Section 3
Water Resources

This section describes current approaches to surface water, groundwater, water quality, and water supplies. This section describes associated study area, the environmental setting, the significance of potential environmental impacts, and potential mitigation measures.

The Delta Plan (the Proposed Project) does not propose implementation of any particular physical project; rather it seeks to influence, either through limited policy regulation or through recommendations, other agencies to take certain actions that will lead to achieving the dual goals of Delta and Suisun Marsh (Delta) ecosystem protection and water supply reliability. Those actions, if taken, could lead to physical changes in the environment. This is described in more detail in part 2.1 of Section 2A, Proposed Project and Alternatives, and in Section 2B, Introduction to Resource Sections.

Construction and operational impacts would be associated with water supply reliability, ecosystem restoration, water quality improvement, flood risk reduction, and enhancement actions primarily in the Delta and in the Delta watershed and to a lesser extent in areas outside the Delta that use Delta water. The types of impacts related to water resources include those related to construction and operations impacts that cause violations of water quality standards or waste discharge requirements, deplete groundwater supplies, alter existing drainage patterns, degrade water quality, or change water supply availability.

Construction- and operations-related impacts related to resources could be significant depending on various project- and site-specific factors that are presently undefined. This section identifies mitigation that could be considered by lead agencies to develop specific mitigation measures for future projects involving water resources. The mitigation may reduce impacts to less than significant; however, depending on the specific characteristics of the project and the environment, not all mitigation measures identified would mitigate impacts to a less-than-significant level.

3.1 Study Area

Water resources supply and management vary throughout California depending on population, economic, and environmental needs. The study area includes three main areas: the Delta and Suisun Marsh, the Delta watershed, and the areas outside of the Delta that use Delta water. The Delta watershed includes the tributary rivers that flow into the Delta from the Sacramento River watershed and the San Joaquin River watershed. The main rivers are the Sacramento River, Feather River, Yuba River, Bear River, American River, San Joaquin River, Fresno River, Chowchilla River, Merced River, Tuolumne River, Stanislaus River, Calaveras River, and Cosumnes River. In general, the Delta watershed is represented by the drainage of the Central Valley except for the Tulare Lake area. Areas outside of the Delta that use Delta water include Tulare Lake, San Francisco Bay, Central Coast, and Southern California. Figure 3-1 shows the study areas as defined for this analysis, along with major statewide water supply infrastructure.

Figure 3-1
Statewide Water Supply Infrastructure
Source: AECOM/CH2M HILL 2011

As described in Section 2A, Description of Proposed Project and Alternatives, facilities could be constructed, modified, or re-operated in the Delta, Delta watershed, or areas located outside the Delta that use Delta water. It is unclear where these facilities would be located. While it is unclear where the Proposed Project or the alternatives will have effects outside the Delta, this section discusses generally discusses water resources in the Delta, Delta watershed, and areas outside the Delta that use Delta water.

3.2 Regulatory Framework

Appendix D, Regulatory Framework, provides an overview of the plans, policies, and regulations relating to water resources within the study area.

3.3 Environmental Setting

This section describes the water resources that could be potentially affected as a result of adopting the proposed Delta Plan or implementing the alternatives. California water resources are affected by surface water and groundwater in the Delta watershed, Delta, and areas located outside of the Delta that use Delta water. Therefore, this section describes water resources within the Delta and includes a general discussion of water resources in other areas.

3.3.1 Major Sources of Information

Most of the information in this section is summarized or taken directly from existing documents. The description of the environmental setting for water resources was primarily based on the following sources of information:

- Department of Water Resources (DWR):
  - Bulletin 160: California Water Plan Update 2009
  - Bulletin 118: California's Groundwater 2003 Update
  - California Data Exchange Center
- U.S. Geological Survey (USGS):
  - Professional Paper 1766 (2009)
  - Studies from the Groundwater Ambient Monitoring and Assessment Program
- CALFED Bay-Delta Program (CALFED) Environmental Impact Report (EIR) (2000)
- Central Valley Project Improvement Act (CVPIA) Programmatic Environmental Impact Study (1997–1999)
- Urban Water Management Plans for various regions
- Integrated Regional Water Management Plans (IRWMPs) for various regions
- Groundwater Management Plans for various basins

3.3.2 Overview of California Water Resources

Variability and uncertainty are the dominant characteristics of California's water resources. Precipitation is the source of 97 percent of California's water supply. It varies greatly from year to year, as well as by season and where it falls geographically in the state. With climate change, the state's precipitation is expected to become even more unpredictable.

In an average water year, precipitation provides California with about 200 million acre-feet (MAF) of water falling as either rain or snow (DWR 2009a).[1] However, the total volume of water the state receives can vary dramatically between dry and wet years. California may receive less than 100 MAF of water during a dry year and more than 300 MAF in a wet year (Western Regional Climate Center 2011). Out of all precipitation that California receives, over half evaporates,[2] which leaves about 40 to 50 percent of the water available for use in urban areas, agriculture, and the environment, collectively.

The unpredictability and geographic variation in precipitation that California receives make it challenging to manage the available runoff to meet urban and agricultural water needs. The majority of California's precipitation occurs between November and April, yet most of the state's demand for water is in the hot, dry summer months. In addition, most of the precipitation falls in the mountains in the northern half of the state, far from major population and agricultural centers. In some years, the far north of the state can receive 100 inches or more of precipitation, while the southernmost regions receive only a few inches (Western Regional Climate Center 2011).

The historical record also shows that California has frequently experienced long multi-year droughts, as well as extremely wet years that coincide with substantial flooding (Hanak et al. 2011). Since 1906, one-third of the water years in California have been considered by the DWR to have been "dry or critically dry"; the percentage has increased to 37 percent since 1960, which is consistent with the predicted effects of climate change on California (DWR 2011a).

To cope with this hydrologic variability and also manage floods during wet years, State, federal, and local agencies have constructed a vast interconnected system of surface reservoirs, aqueducts, and water diversion facilities over the last hundred years. This system helps California to store and convey water supplies from areas that have water available to areas that have water needs. In most regions of the state, these imported water supplies supplement local and regional water sources.

California has over 1,400 major reservoirs with a combined storage capacity of 43 MAF, about half the average annual statewide runoff (Hanak et al. 2011; DWR 2011b). Thousands of miles of canals and large pumps have been constructed to move water around the state. The first major regional storage and conveyance projects were developed to store and convey water from the Delta watershed in the Sierra Nevada and from the Owens Valley to the rapidly growing regions in the San Francisco Bay Area and Southern California, respectively.[3] The state's largest and most recent projects are the State Water Project (SWP) and the Central Valley Project (CVP), which were mostly constructed between 1930 and 1970. These projects were designed to export water from the Delta watershed and provide supplemental water for agricultural and urban uses, primarily in the Central Valley and Southern California (Figure 3-2).

The CVP stores water in Shasta Lake—the largest reservoir in the CVP with a storage capacity of 4.5 MAF—and conveys it in the Sacramento River downstream to the Delta. Water from the Trinity and American Rivers is also stored and reregulated for release into the Sacramento River. CVP water is conveyed through the Delta to the Jones Pumping Plant in Tracy at the southern end of the Delta, where the pumps lift the water into the Delta-Mendota Canal, which delivers water to CVP contractors in the San Joaquin Valley. CVP water is also conveyed via the San Luis Reservoir and Pacheco Tunnel to the San Felipe Division contractors and via the San Luis Canal to San Luis contractors.

[1] Includes up to 10 MAF of water flowing into California from Oregon, Mexico, and the Colorado River.

[2] Includes evaporation, evapotranspiration of native vegetation, groundwater subsurface outflows, and other losses (DWR 2009a).

[3] These included the San Francisco Public Utilities Commission's Hetch Hetchy Project, Los Angeles' Owens Valley and Mono Basin Aqueduct, and the East Bay Municipal Utility District's Mokelumne Aqueduct. Additional projects that brought Colorado River water into California were the Imperial Irrigation District's All-American Canal and the Metropolitan Water District of Southern California's Colorado River Aqueduct.

Figure 3-2
SWP and CVP Facilities
Source: AECOM/CH2M HILL 2011, DWR 2010c

The SWP conveys water from Lake Oroville, the second largest reservoir in California with a storage capacity of approximately 3.5 MAF, on the Feather River and through the Delta system to Southern California. SWP water travels through the San Luis Reservoir and canal before being pumped over the Tehachapi Mountains into Antelope Valley by the Edmonston Pumping Plant. Once over the mountains, the SWP divides into the East Branch and West Branch. On the East Branch, water is pumped by the Pearblossom Pumping Plant into Silverwood Lake. When needed, water is released from Silverwood Lake into Lake Perris via the Santa Ana Pipeline. On the West Branch, water is pumped by Oso Pumping Plant into Quail Lake and then conveyed to Pyramid Lake, where it flows through the into Castaic Lake (DWR 2010a, p.15). The Coastal Aqueduct, which branches off the California Aqueduct near Kettleman City, provides water supplies to the Central Coast counties of Santa Barbara and San Luis Obispo (DWR 1997, p.3).

Historically, local water resources constituted the backbone of California's water supply reliability. Local surface storage and deliveries, together with reuse, account for about 40 percent of the state's developed water supplies. Groundwater is also a significant resource, supplying about 35 percent of the state's water needs, and 40 percent or more during droughts. Imported water from the Colorado River provides 10 percent of the state's developed water supply, serving communities in Southern California. A small amount is attributed to recycled water and other local reuse projects (DWR 2009a).

With the growing limitations on available surface water exported through the Delta, and the potential impacts of climate change, reliance on groundwater through conjunctive management would become increasingly more important in meeting the state's future water uses.

Groundwater occurs throughout the Central Valley, the southeast desert, and in isolated basins on the Coast. About 20 percent of the nation's groundwater demand is supplied from pumping Central Valley aquifers, making it the second-most-pumped aquifer system in the United States (USGS 2009, p.3). DWR has delineated 515 distinct groundwater systems as described in Bulletin 118-03 (DWR 2003). These basins and subbasins have various degrees of supply reliability considering yield, storage capacity, and water quality. Figure 3-3 shows the statewide occurrence of groundwater.

The importance of groundwater as a resource varies regionally. The Central Coast Hydrologic Region has the most reliance on groundwater to meet its local uses, with more than 80 percent of its water use supplied by groundwater in an average year. The Tulare Lake Hydrologic Region meets about 50 percent of its local uses with groundwater extraction. The rest of the Central Valley meets between 15 and 35 percent of local uses with groundwater. In Southern California, the use of groundwater varies between 15 to 35 percent of annual use (South Coast Hydrologic Region) and 70 percent of annual use (South Lahontan Hydrologic Region). In general, of all the groundwater extracted annually in the state in an average year, more than 35 percent is produced in the Tulare Hydrologic Region, and more than 70 percent occurs in the Central Valley (DWR 2009a, p. 8–10).

A comprehensive assessment of overdraft in the state's groundwater basins has not been conducted since Bulletin 118-80 in 1980, but overdraft is estimated at between 1 to 2 MAF annually (DWR 2003, p. 2). In DWR's Bulletin 118-80 (DWR 1980), an assessment of critically overdrafted basins was conducted. Several basins were identified as being in a critical condition of overdraft, as shown in Figure 3-4. Most of these basins are located in the Tulare Lake Basin.

Surface water and groundwater supply planning and operations would be further complicated by climate change—a growing concern for water resources management. An increasing body of evidence indicates that Earth's atmosphere is warming.

Figure 3-3
Groundwater Basins Throughout the State
Source: DWR 2003

Figure 3-4
Critically Overdrafted Groundwater Basins as Identified by DWR
Source: DWR 2003

Historically, precipitation in most of California has been dominated by extreme variability seasonally, annually, and over decade time scales; in the context of climate change, projections of future precipitation are even more uncertain than projections for temperature. Uncertainty regarding precipitation projections is greatest in the northern part of the state, and a stronger tendency toward drying is indicated in the southern part of the state. Climate models project more extreme winter precipitation events, and a more rapid spring melt leading to a shorter, more intense spring period of river flow and freshwater discharge.

As described in Section 21, global and regional sea levels have been increasing steadily over the past century and are expected to continue to increase throughout this century. Sea levels are projected to increase more rapidly in the future as a consequence of three significant influences: increased thermal expansion of water in the oceans caused by global warming, changes in the freshwater input to the oceans from melting glaciers and ice sheets, and changes in water storage on land (Ramsdorf 2007). Recently, the U.S. Army Corps of Engineers (USACE) issued guidance on incorporating sea level change in civil works programs. The guidance reviews the existing literature and suggests using a range of sea level change projections, including the “high probability” of accelerating global sea level rise (USACE 2009).

3.3.3 Delta and Suisun Marsh

The Delta and Suisun Marsh area constitutes a natural floodplain that covers 1,315 square miles and drains approximately 40 percent of the state (DWR 2009a). The Delta and Suisun Marsh have a complex web of channels and islands and is located at the confluence of the Sacramento and San Joaquin rivers.

The area has a Mediterranean climate, and most precipitation occurs between December and March. Annual rainfall averages between 14 and 20 inches, but can vary significantly from one year to the next. Average temperatures range from the low 40s degrees Fahrenheit to the high 90s degrees Fahrenheit and vary across the Delta from hotter in the east to cooler in the west.

Historically, the natural Delta system was formed by water inflows from upstream tributaries in the Delta watershed and outflow to Suisun Bay and San Francisco Bay. The Sacramento River watershed and tributaries east of the Delta supplied roughly 85 percent of these flows, and the San Joaquin River provided about 15 percent (LAO 2008). In the late 1800s, local land reclamation efforts in the Delta resulted in the construction of channels and levees that began altering the Delta’s surface water flows.

Over time, the natural pattern of water flows continued to change as the result of upper watershed diversions and the construction of facilities to divert and export water through the Delta to areas where supplemental water supplies are needed, including densely populated areas such as San Francisco and Southern California and agricultural regions such as the San Joaquin Valley and Tulare Lake. The SWP and CVP use the Delta as the hub of their conveyance systems to deliver water to large pumps located in the southern Delta.

3.3.3.1 Surface Water Hydrology

Inflows to the Delta occur primarily from the Sacramento River system with some flows originating in Yolo Bypass, the San Joaquin River, and other eastside tributaries such as the Mokelumne, Calaveras, and Cosumnes rivers. In general, in any given year, approximately 77 percent of water enters the Delta from the Sacramento River, approximately 15 percent enters from the San Joaquin River, and approximately 8 percent enters from the eastside tributaries (DWR 1994, p. 246). The Delta is tidally influenced; rise and fall varies from less than 1 foot in the eastern Delta to more than 5 feet in the western Delta (DWR 2009a). The Suisun Marsh contains tidal wetlands (about 7,672 acres) and managed wetlands. The managed wetlands are separated from the tidal sloughs by exterior levees, and water exchange is controlled by gated culverts (Reclamation et al. 2010, p. 5.1-9).

On the average, about 21 MAF per year of water, or about 42 percent of the surface water in California, reaches the Delta. Actual flow varies widely from year to year, and within the year as well. In 1977, a year of extraordinary drought, inflow to the Delta totaled 5.9 MAF. In 1983, an example of an extremely wet year, annual inflow was about 70 MAF per year. Approximately 50,000 acres of the Delta is covered by surface water, and approximately 520,000 acres of Delta land is used for agriculture (Reclamation 1997, p. II-55).

Delta channels have been modified to allow transport of this water and to reduce the effects of pumping on the direction of flows and salinity intrusion. The conveyance of water from the Sacramento River southward through the Delta is aided by the Delta Cross Channel, a constructed, gated channel that conveys water from the Sacramento River to the Mokelumne River. Water diversions in the Delta include the CVP's Jones Pumping Plant, the SWP's Banks Pumping Plant, the Contra Costa Canal Pumping Plant, the SWP's North Bay Aqueduct, and over 1,800 agricultural diversions for in-Delta use (DWR 2010a, p. 16).

3.3.3.2 Surface Water Quality

Water quality in the Delta is highly variable and strongly influenced by inflows from the rivers and by seawater intrusion into the western and central portions of the Delta during periods of low outflow that may be affected by high volumes of export pumping. The concentrations of salts and other materials in the Delta are affected by river inflows, tidal flows, agricultural diversions, drainage flows, wastewater discharges, water exports, cooling water intakes and discharges, and groundwater accretions.

Average water quality concentrations of these and a variety of constituents for Delta outflow locations are shown in Appendix E, Table E-1.

Salinity is of particular concern in the tidally influenced Delta because of the artificially modified nature of the Delta islands and channels, which hold saline bay waters farther downstream than would occur if the Delta had been left as a series of flooded wetlands (CALFED 2008, p. 59). Any failure of Delta levees and subsequent island flooding draws saline water into the Delta. Salinity in the Delta is subject to control through modifications caused by exports and floods, with climate as the primary long-term driver (Enright and Culberson 2009). The exports dampen seasonal salinity patterns. However, such factors as depth increases in Suisun Bay, related to the gradual downstream passage of mining sediments, have produced a long-term trend of increasing salinity in Suisun Bay (Enright and Culberson 2009). A return to more natural, seasonally variable salinity patterns likely would benefit the native fish and be less supportive of many of the invasive freshwater species.

Salinity objectives for the southern Delta are now under review because of San Joaquin River flow modifications and concerns for agricultural and fisheries beneficial uses (SWRCB 2008, pp. 62–63, SWRCB 2010a). Flow modifications and physical diversion structures influence Delta salinity patterns.

Nutrients, primarily nitrogen compounds (N) and phosphorus (P), may trigger excessive growth of algae or toxic blue-green cyanobacteria. Primary sources of nutrients are erosion, agricultural runoff, urban runoff, and treated effluent. The Sacramento Regional Wastewater Treatment Plant is the largest point source of ammonia in the Delta (Jabusch and Foe 2010). Low dissolved oxygen (DO) is a concern in the interior Delta because of enhanced treated effluent loading from Stockton, agricultural runoff, and reduced flushing of dead-end channels. Middle River, Old River, and the Stockton Deep Water Ship Channel are listed as impaired due to DO depletion, with DO concentrations criteria set at 6 milligrams per liter (mg/L) minimum for the San Joaquin River between Turner Cut and Stockton (SWRCB 2006). Loading from the Stockton Regional Wastewater Control Facility has the greatest effect in reducing DO, with hydrologic flushing, temperature, and phytoplankton being less important (Jassby and Niewenhuyse 2005). The emergence of increased concentrations of harmful algae blooms (HABs) over the last 10 years is indicative of potential problems with water stagnation, nutrient loading, and temperature increase. The cyanobacterium *Microcystis aeruginosa* has been an increasing component of summer HABs in the Delta (Lehman et al. 2008). In addition to HABs, invasive aquatic weeds such as water hyacinth (*Eichhornia* *crassipes*) and Brazilian waterweed (*Egeria densa*) are becoming increasingly common in the Delta (Santos et al. 2011). Research would be needed to provide causal links between the growth of these problem aquatic weeds and blue-green algae and nutrient loads. However, it should be expected that factors influencing flow patterns and nutrient accumulation and loads are likely to affect future weed growth and HABs in the Delta.

The State Water Resources Control Board (SWRCB) listed the Delta (and portions of San Francisco Bay) as having impaired water quality for selenium under Clean Water Act Section 303(d) (San Francisco Bay RWQCB 2009, pp. 65–66). Consequently, the San Francisco Bay Regional Water Quality Control Board (San Francisco Bay RWQCB) is attempting to address selenium toxicity in North San Francisco Bay (North Bay), which is defined to include a portion of the Delta, Suisun Bay, Carquinez Strait, San Pablo Bay, and the Central Bay (San Francisco Bay RWQCB 2011). The main watershed source of selenium to the Delta is agricultural drainage from the San Joaquin Valley (Presser and Luoma 2006, pp. 1–2; Lucas and Stewart 2007, p. 14; Entrix 2008, p. ES-2; San Francisco RWQCB 2008, p. 1-1). The pattern of bioaccumulated selenium in largemouth bass can be seen in Appendix E, Table E-2 and Figure E-1. Central Valley sources are apparent with the general decrease toward the Bay.

Historic mining operations have resulted in large inputs of mercury to the Delta and subsequent uptake by fish, causing tissue concentrations in exceedance of national health guidelines for fish consumption (Central Valley RWQCB 2010a). The pattern of largemouth bass mercury tissue concentrations is shown in Appendix E, Table E-3 and Figure E-2, showing higher concentrations of mercury and methylation experienced in the Cosumnes River eastside tributary as compared to interior locations such as Franks Tract (DiPasquale et al. 2005; Melwani et al. 2009, pp. 6–12). This pattern is reflected in mercury and methylmercury concentrations throughout the Delta. Fish mercury concentrations generally exceed the Central Valley RWQCB total maximum daily load (TMDL)[4] target goal (the water quality goal expressed as fish tissue concentrations) of 0.24 mg mercury/kg wet weight (refer to Appendix D, Regulatory Framework).

A variety of bioaccumulative contaminants are found throughout the Delta, resulting in fish advisory limits such as those for the Port of Stockton stating that no fish or shellfish should be consumed because of contamination from mercury, dioxins, furans, and polychlorinated biphenyls (PCBs) (OEHHA 2007). A statewide study of fish that included the Delta concluded that mercury and PCBs were the most common contaminants bioaccumulated into fish at levels of concern; the other detectable contaminants in tissue included selenium, dieldrin, DDT, chlordane but generally low in concentration (Davis et al. 2010).

Over 100 types of pesticides are commonly used on the agricultural lands upstream of and in the Delta and in urban areas, and these are transported in runoff to Delta waters. Toxicity studies have frequently linked toxicity in the Delta to pesticides (Kuivila and Hladik 2008), and the Delta is listed as impaired because of diazinon and chlorpyrifos (refer to Appendix D, Regulatory Framework). There are defined seasonalities to application and runoff: winter runoff includes dormant sprays and herbicides, spring includes insecticides, and summer includes runoff of rice pesticides (Kuivila and Hladik 2008.) Average water quality concentrations of a variety of constituents for several Suisun Marsh and Suisun Bay locations are shown in Appendix E, Table E-4. Note that the marsh is lower in salinity than the bay because of freshwater inflow. The marsh has generally higher concentrations of metals but similar nutrient contents as compared to the bay (Table E-4).

The SWRCB listed the Suisun Marsh Wetlands as having impaired water quality for “metals” under Clean Water Act Section 303(d) (San Francisco Bay RWQCB 2009, p. 79). Although selenium is not identified in the listing for the Suisun Marsh Wetlands, it is identified as a pollutant/stressor for the listing of adjacent Suisun Bay (San Francisco Bay RWQCB 2009, pp. 78–79). The response to impaired water

[4] A total maximum daily load, or TMDL, is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards (http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/).

body listings, along with a list of current TMDL programs, is provided in Appendix D, Regulatory Framework.

3.3.3.3 Groundwater Hydrology

Groundwater levels in the central Delta are very shallow, and land subsidence on several islands has resulted in groundwater levels close to the ground surface. Maintaining groundwater levels below crop rooting zones is critical for successful agriculture, especially for islands that lie below sea level, and many farmers rely on an intricate network of drainage ditches and pumps to maintain groundwater levels of about 3 to 6 feet below ground surface. The accumulated agricultural drainage is pumped through or over the levees and discharged into adjoining streams and canals (USGS 2000). Without this drainage system, the islands would become flooded.

Extensive hydraulic interaction occurs between the surface water and groundwater systems. Spring runoff generated by melting snow in the Sierra Nevada increases flows in the Sacramento and San Joaquin rivers and tributaries and causes groundwater levels near the rivers to rise. Because the Delta is a large floodplain and the shallow groundwater is hydraulically connected to the surface water, changes in river stages affect groundwater levels and vice versa. This hydraulic connection is also evident when the tide is high and surface water flows from the ocean into the Delta, thereby increasing groundwater levels nearby. In addition, groundwater quality can be degraded by saltwater intrusion in the underlying aquifer from the ocean tidal flows. Delta floodplain deposits contain a significant percentage of organic material (peat) ranging in thickness from 0 to 150 feet. Below the surficial deposits, unconsolidated non-marine sediments occur up to 3,000 feet thick. These sediments form the major water bearing formations in the Delta.

The Delta overlies portions of four groundwater subbasins as defined by DWR: the South American subbasin to the northeast bounded by the Sacramento and the Cosumnes rivers, the Solano subbasin to the northwest, the East San Joaquin subbasin in the central and eastern Delta, and the Tracy subbasin, which underlies the southern half of the Delta.

Groundwater in the South American and Eastern San Joaquin subbasins generally flows from the Sierra Nevada on the east toward the low-lying lands of the Delta to the west. However, a number of pumping areas have reversed this trend, and groundwater inflow from the Delta toward these pumping areas has been observed.

Groundwater levels in the South American subbasin have fluctuated over the past 40 years, with the lowest levels occurring during periods of drought. From 1987 to 1995, water levels declined by about 10 to 15 feet and then recovered by the same amount until 2000, to levels close to the mid-eighties. Areas affected by municipal pumping show a lower groundwater level recovery than other areas (DWR 2004a, p. 2). Total dissolved solids (TDS) levels range from 24 to 581 mg/L, with an average of 221 mg/L based on 462 records (DWR 2004a, p. 3). Seven sites present significant groundwater contamination is this basin, including three superfund sites near the Sacramento metropolitan area. These sites are in various stages of cleanup. Groundwater levels in the East San Joaquin subbasin have continuously declined in the past 40 years due to groundwater overdraft. Cones of depression are present near major pumping centers such as Stockton and Lodi (DWR 2006a, p. 2). Groundwater level declines of up to 100 feet have been observed in some wells. TDS levels range widely between 50 and 3,520 mg/L. The high salinity of groundwater is attributed to poor-quality groundwater intrusion from the Delta caused by the decline of groundwater levels. This saline groundwater front has been particularly apparent in the Stockton area. High chloride concentrations have also been observed in well water in the Eastern San Joaquin subbasin. The source of chloride concentrations of up to 1,800 mg/L near the Delta may be due to saline water intrusion from the Delta, but other sources are possible, such as high-chloride water moving upward from the deeper saline formations as a consequence of extensive groundwater pumping and agricultural return flows (USGS 2006a). In addition, large areas of groundwater with elevated nitrate concentrations exist in several portions of the subbasin, such as southeast of Lodi and south of Stockton.

In the Solano subbasin, historical general groundwater flow direction is from northwest to southeast. Water-bearing units underlying the Solano subbasin range in thickness from 1,500 to 2,500 feet and provide important well yield capacities of up to several thousand gallons per minute (gpm) (DWR 2004b, p. 1). Increasing agricultural and urban development in the 1940s in the Solano subbasin has caused groundwater level declines. Today, groundwater levels are mostly impacted by drought cycles but tend to recover quickly during wet years (DWR 2004b, p.2). Groundwater quality in the Solano subbasin is generally good and is deemed appropriate for domestic and agricultural use (DWR 2004b, p. 3). However, TDS concentrations at levels higher than 500 parts per million have been observed in the central and southern areas of the basin.

In the Tracy subbasin, groundwater generally flows south to north and discharges into the San Joaquin River. According to DWR and the San Joaquin County Flood Control and Water Conservation District, groundwater levels in the Tracy subbasin have been relatively stable over the past 10 years, apart from seasonal variations resulting from recharge and pumping (DWR 2006b, p. 2). In the Tracy subbasin, areas of poor water quality exist throughout. Elevated chloride concentrations are found along the western side of the subbasin near the City of Tracy and along the San Joaquin River. Overall, Delta groundwater wells in the Tracy subbasin show levels above the secondary maximum contaminant level for chloride, TDS, arsenic, and boron (USGS 2006b).The Suisun Marsh overlies the Suisun-Fairfield Valley groundwater basin, which is part of the San Francisco Bay Hydrologic Region (DWR 2003). This basin is characterized by unconsolidated to semiconsolidated sedimentary deposits and is bounded by the Coast Ranges to the west and north, the Sacramento groundwater basin to the east, and the Delta and Suisun Bay to the south (USGS 2008). This groundwater basin recharges by infiltration on the Suisun Valley floor and along stream channels, and drains generally southward into Suisun Marsh, Groundwater in the Suisun-Fairfield basin is generally of poor quality.

3.3.3.4 Water Use and Infrastructure

Delta water is used by two-thirds of California's population (DWR 2009a). The Delta also supplies water to more than 700 million acres of irrigated land in various regions of California: San Francisco Bay, Central Coast, San Joaquin Watershed, Tulare Lake, and Southern California. Water supply in the Delta is primarily from local surface water and groundwater. The two largest diverters of Delta water are the CVP and SWP. This water is exported to the South Bay Area, Napa County, Solano County, and other locations around the San Francisco Bay Area, San Joaquin Valley, and Southern California for urban and agricultural uses.

3.3.3.4.1 Surface Water Use

The primary consumptive water users in the Delta are agricultural and urban. These users divert water from the Delta and its tributaries at over 1,800 diversion points and may not have fish screens or meters. These diversions can total more than 5,000 cubic feet per second (cfs) in July and August (DWR 2010a, p. 16). Return flows from these diversions are discharged back to the Delta. Local agencies, private entities, and agricultural users operate their own diversion infrastructure. It is estimated that in 2003, Delta agriculture used approximately 1.3 MAF (DWR 2009a) of water locally through surface water diversion or pumping of shallow groundwater. After local users, the major users of Delta surface water are the CVP and SWP. In Suisun Marsh, the managed wetlands in the Marsh receive water supplies through riparian and appropriative water rights. Water supply is used for waterfowl habitat flooding operations and soil leaching for vegetation management. The majority of diversions occur in October and November, which marks the beginning of the waterfowl-habitat flooding period (Reclamation et al. 2010, p. 5.1-22).

The major Delta surface water diversions are summarized below.

Freeport Regional Water Authority recently completed an intake facility to divert up to 185 million gallons per day (mgd) of water from the lower Sacramento River at Freeport (Freeport Regional Water Authority 2004). The water is conveyed to be used by the Sacramento County Water Agency and East Bay Municipal Utility District (EBMUD). The Freeport Regional Water Project will be completed in 2012.

The SWP facilities in the Northern Delta include the North Bay Aqueduct and Barker Slough Pumping Plant in the northern Delta. The Barker Slough Pumping Plant pumps water from Barker Slough into the North Bay Aqueduct for export to the northern areas of the San Francisco Bay Area and Suisun Marsh. The Barker Slough Pumping Plant has a maximum pumping capacity of 175 cfs, and the average annual pumping rate is approximately 35 cfs (CALFED 2000, p. 5.1-5). The North Bay Aqueduct supplies water to Solano County Water Agency and Napa County Flood Control and Water Conservation District. Solano County Water Agency provides water to the cities of Benicia, Vallejo, Vacaville, and Travis Air Force Base. Napa County Flood Control and Water Conservation Agency provides water from the North Bay Aqueduct to the cities of Napa, American Canyon, Saint Helena, Calistoga, and the town of Yountville. The City of Vallejo has a water right to divert water from the Delta at Barker Slough. This water is conveyed via the North Bay Aqueduct (CALFED 2005). In addition, Suisun City, Rio Vista, and Dixon have rights to North Bay Aqueduct water but do not have conveyance facilities to receive water.

Contra Costa Water District (CCWD) diverts water from the Delta under water rights and as a CVP contractor. CCWD diverts water under water rights at Mallard Slough. Diversion of this water is frequently restricted due to poor water quality in the San Joaquin River. CCWD has Los Vaqueros Project water rights on Old River and on the Victoria Canal. CCWD has a contract under CVP for diversion at Rock Slough, Old River, and Victoria Canal. CCWD’s major reservoir is Los Vaqueros Reservoir, which is currently undergoing expansion. This surface storage is mainly used to control and improve the quality of Delta water distributed to CCWD customers.

The City of Antioch has a water right on the Sacramento/San Joaquin Rivers Delta, and is a customer of the CCWD. Whenever the river salinity is at an acceptable level (chloride concentration less than 250 mg/L), the water rights water is used. Whenever the river salinity level is unacceptable, or when demand exceeds the existing pumping capacity, the City purchases substitute or additional water supplies directly from the CCWD.

The City of Stockton is currently constructing a 30-mgd intake facility as part of the Delta Water Supply Project to divert water along the San Joaquin River at Empire Tract (City of Stockton 2011).

The other CVP facilities in the Delta include the Jones Pumping Plant at Tracy and the Delta Cross Channel located at Walnut Grove. The Delta Cross Channel links the Sacramento River with the Mokelumne River system to improve water circulation within the northern and central Delta. The CVP Tracy Pumping Plant has a maximum capacity of approximately 4,600 cfs (CALFED 2000, p. 5.1-5; DWR 2010a, p. 16). The CVP pumps water to the CVP users in San Joaquin Valley, Santa Benito County, and Santa Clara County.

The SWP Banks Pumping Plant supplies water for the South Bay Aqueduct (Alameda and Santa Clara counties) and the California Aqueduct (San Joaquin Valley, Central Coast, and Southern California). The total installed capacity of the pumping plant is 10,300 cfs. Permitting constraints on the pumping plant have limited the pumping capacity to 6,680 cfs during most of the year (DWR 2010a, p. 16). Clifton Court Forebay serves as a regulating reservoir for the Banks Pumping Plant.

The CVP and SWP coordinate their facility operations based on the Coordinated Operating Agreement, the Bay Delta Accord, SWRCB Decision 1641, U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) Biological Opinions, and other agreements. Before December 2007, the CVP and SWP exported about 3.4 MAF per year from the Jones Pumping Plant, and about 3.5 MAF per year from the Banks Pumping Plant (CCWD 2006, p. 4.2-11). Since 2007, the level of CVP and SWP exports from the Delta has been significantly reduced. In 2008, water exports at the Banks Pumping Plant totaled about 1.2 MAF, and in 2009 they totaled about 1.8 MAF (DWR 2008, 2009b). At the Jones Pumping Plant, 2008 exports totaled about 1.8 MAF, and in 2009 about 1.9 MAF (Reclamation 2011a).

As described in subsection 2.3.2, continued reliability of CVP and SWP water supplies in the Delta has been reduced over the past 20 years through implementation of water quality objectives, water rights decisions, and biological opinions. These activities limit the time during which freshwater flows can be conveyed from the Sacramento River through the Delta to the south Delta CVP and SWP pumping plants. The ability of the CVP and SWP to convey water from the Delta is further limited by the capacity of conveyance and storage facilities in areas outside of the Delta that use Delta water. Periodically, CVP and SWP south Delta pumping plant operations have been interrupted for short periods of time when Delta levees have failed and high saline water has flowed into the central and south Delta and reduced water quality to water conveyed by the CVP and SWP.

3.3.3.4.2 Environmental Water Use

Water quality and flow requirements in the Delta are governed by SWRCB Decision 1641 (D-1641) and the 2006 Water Quality Control Plan (WQCP). D-1641 was issued in December 1999 and provides water quality and flow objectives that are required to be met as part of the water rights of DWR and the U.S. Bureau of Reclamation (Reclamation) to operate the SWP and CVP facilities in the Delta. The WQCP was adopted in December 2006 and reflects the objectives contained in D-1641 (Reclamation 2008, p. 1-6).

In recent years, environmental water requirements in the Delta have been driven primarily by the biological opinions developed by the USFWS in December 2008 and by the NMFS in June 2009. The USFWS Biological Opinion was remanded by the court in December 2010 and is currently being revised, though parts of that opinion remain in effect pending the revision, and a court challenge to the NMFS Biological Opinion is still pending. These requirements affect the operational criteria for the SWP and CVP. For example, the SWP and CVP coordinate project operations to maintain flow standards set forth by the biological opinions; this is accomplished by releasing water from upstream reservoirs for in-Delta and Delta outflow requirements and by restricting exports from the south Delta pumping plants during specific times, among other things (DWR 2009a).

Several CVPIA provisions are related to uses of environmental water accounts, including dedication of 800,000 acre-feet to fish, wildlife, and habitat restoration under Section 3406(b)(2), which was issued by the Department of the Interior on May 9, 2003. These actions generally occur through instream flow augmentation below CVP reservoirs or reductions in export pumping at the CVP’s Jones Pumping Plant (see Appendix D, Regulatory Framework).

3.3.3.4.3 Groundwater Use

Groundwater is used throughout the Delta and occurs through pumping and through plant uptake in the root zone. Because groundwater is used by private users and by natural processes (plant uptake), accurate measurements of water used in the region are not available. In the rural portions of the Delta, private groundwater wells provide domestic water supply (Camp Dresser & McKee 2005). In the central Delta, groundwater use is limited because of low well yields and poor water quality. Shallow groundwater occurring at depths of less than 100 feet is too saline and not adequate for most beneficial uses. Approximately 200 square miles of the central Delta are affected by saline shallow groundwater (CALFED 2000, p. 5.4-7). Because shallow groundwater levels are detrimental when they encroach on crop root zones, groundwater pumping is used to drain the waterlogged agricultural fields. Groundwater pumping for agricultural operations mostly occurs in the north Delta for orchards and in the south Delta around the City of Tracy. Average annual groundwater pumping is estimated to range between

100,000 and 150,000 acre-feet in upland peripheral Delta areas, both for domestic and agricultural uses (CALFED 2000, p. 5.4-8).

The City of Stockton depends almost entirely on groundwater for its municipal and industrial water needs. Groundwater also provides water supply for the Delta communities of Clarksburg, Courtland, Freeport, Hood, Isleton, Rio Vista, Ryde, and Walnut Grove.

Groundwater use in the CCWD service area is approximately 3,000 acre-feet per year with another 500 acre-feet per year produced by the city of Pittsburg. Groundwater is produced at the CCWD's Mallard Wells and wells owned and operated by the city of Pittsburg, Golden State Water Company, and Diablo Water District. In addition, an undetermined number of privately held groundwater wells exist in the CCWD service area (CALFED 2005). Groundwater in this area is primarily produced from the Clayton basin, which has seen a gradual decline in groundwater elevation (CCWD 2005).

Information on groundwater supplies in the Suisun-Fairfield Valley basin is limited. However, studies have shown that the basin provides low well yields and therefore is probably not used as a major water supply (Reclamation et al. 2010, p. 5.3-10). Many private well owners in the Suisun Marsh basin use groundwater for landscape irrigation. However, the poor quality of the Suisun Marsh basin groundwater prevents municipal use and potable water is typically imported (Reclamation et al. 2010, p. 5.3-10).

3.3.3.4.4 Water Recycling and Water Conservation

Limited water recycling occurs in the Delta area. Currently, approximately 10,000 acre-feet per year of recycled water are produced in the area by City of Stockton, CCWD, and the Fairfield-Suisun Sewer District. The City of Benicia and City of Fairfield have plans to increase recycling in the area. These projects could increase reuse to over 16,000 acre-feet per year. The City of Stockton produces approximately 20 acre-feet per year of recycled water for agricultural irrigation. The remainder of flow (approximately 31,000 acre-feet per year) is discharged to San Joaquin River. CCWD produces approximately 9,000 acre-feet of recycled water for landscape irrigation at parks, golf courses, and other city- or State-owned facilities as well as for cooling water and boiler water at two local energy centers. The Fairfield-Suisun Sewer District recycles about 10 percent of its effluent. Recycled water is used to irrigate landscape and agricultural as well as discharge to the Suisun Marsh.

3.3.4 Delta Watershed

Discussion of the Delta watershed is divided into its two major tributaries: the Sacramento River watershed and the San Joaquin River watershed.

3.3.4.1 Sacramento River Watershed

The Sacramento River flows generally north to south from its source near Mount Shasta to the Delta, and receives contributing flows from numerous major and minor streams and rivers that drain the east and west sides of the basin, including Cottonwood Creek, Thomes Creek, Butte Creek, Feather River, Yuba River, Bear River, and American River. The upper portion of the Sacramento River is fed by tributary flows from numerous small creeks, primarily those draining the western slopes of the Cascade Range and Sierra Nevada. The volume of flow increases as the river progresses southward, and is increased considerably by the contribution of flows from the Feather River and the American River watersheds (DWR 2009a, p. SR-3).

The northernmost area is characterized by cold, snowy winters with only moderate rainfall, and hot, dry summers, with a total average annual precipitation of about 60 to 70 inches (Reclamation 1997, p. III-2). The mountainous parts in the north and east typically have cold, wet winters with large amounts of snow providing runoff for summer water supplies. The Sacramento Valley floor has mild winters and hot, dry summers with precipitation of about 15 to 20 inches per year (Reclamation 1997, p. III-2).

3.3.4.1.1 Surface Water Hydrology

Flows in the upper Sacramento River are regulated by the CVP's Shasta Dam (completed in 1945) and re-regulated approximately 15 miles downstream at Keswick Dam (completed in 1950). The portion of the river above Shasta Dam drains about 6,650 square miles and produces average annual runoff of 5.7 MAF. As the Sacramento River nears Red Bluff, flows become more influenced by the inflow from major tributary streams, including Clear, Cow, Bear, Cottonwood, Battle, and Paynes creeks. The lower Sacramento River extends down to the point where the Sacramento River enters the Delta. The drainage area of the Sacramento River upstream of this location encompasses more than 24,000 square miles (Reclamation 1997, p. III-2 to III-5). Since 1964, a portion of the flow from the Trinity River Basin has been exported to the Sacramento River Basin through CVP facilities. An average of about 732,400 acre-feet of water is diverted from Whiskeytown Lake to Keswick Reservoir annually (USFWS 2004, p. 3-14).

The Feather River, with a drainage area of 3,607 square miles on the east side of the Sacramento Valley, is the largest tributary to the Sacramento River below Shasta Dam. Flows on the Feather River are regulated by Oroville Dam, the lowermost reservoir on the river, which began operation in 1967 as part of the SWP. Oroville Reservoir has a storage capacity of approximately 3.5 MAF. Prior to the construction of Oroville Dam, flows in the Feather River reflected natural runoff conditions, with peak flows in the months of March, April, and May. Following the construction of Oroville Dam, the average monthly flow pattern was modified to provide reduced flows during the spring months and increased flows during summer months (Reclamation 1997, p. III-5).

The Yuba River is a major tributary to the Feather River, historically contributing over 40 percent of the flow, on a total annual basis, as measured at Oroville. The Yuba River originates in the Sierra Nevada, drains approximately 1,339 square miles of the eastern Sacramento Valley, and flows into the Feather River near the town of Marysville (Reclamation 1997, p. III-5. The Bear River originates below the Sierra crest northeast of Emigrant Gap. It flows through Camp Far West Reservoir and into the Feather River just upstream of the Sacramento River.

The American River originates in the mountains of the Sierra Nevada range, drains a watershed of approximately 1,895 square miles, and enters the Sacramento River at River Mile 60 in the City of Sacramento. The watershed ranges in elevation from 23 feet to over 10,000 feet, and receives approximately 40 percent of its flow from snowmelt runoff (Reclamation 1997, p. III-6).

Releases from reservoirs in the Sacramento River watershed are used to meet Delta outflow requirements. In addition, excess flows in the Sacramento River watershed that exceed the total Delta water allocated use contribute to outflows to the ocean.

The surface water and groundwater systems in the Sacramento Valley are very strongly connected. The typically high groundwater levels in the Sacramento Valley cause the major rivers and the lower reaches of many of the tributary streams to gain flow through groundwater discharge. These stream accretions generally have cool temperatures and provide steady base flows that contribute to favorable in-stream conditions for fish. Higher reaches of the tributary streams and rivers located near areas of locally depressed groundwater levels typically lose water to the underlying aquifer system. Groundwater in both the Sacramento Valley and Redding Groundwater Basins is typically replenished through stream leakage and the deep percolation of winter precipitation and applied irrigation water. The quantities of groundwater that discharge into surface streams and the quantities of surface water that percolate into underlying aquifers change temporally and spatially, and are poorly understood. Estimates of these surface water/groundwater exchange rates have been developed for specific reaches on a limited number of streams in the Sacramento Valley (USGS 1985), but a comprehensive valley-wide accounting has not been performed to date.

3.3.4.1.2 Surface Water Quality

Water quality of the Sacramento River is dominated by the mainstem river as it exits Shasta Reservoir with major contributions from the Feather, Yuba, and American rivers and Cottonwood, Cache, and Putah creeks. The major reservoirs (Shasta, Keswick, Oroville, Englebright, Folsom, Clear Lake, and Berryessa) influence downstream water quality through sediment and contaminants removal (for example, mercury in the sediments of Englebright Reservoir and Clear Lake or heavy metals in Keswick Reservoir). The reservoirs have had a profound influence on sediment transport throughout the river, Delta, and San Francisco Bay system with the Delta and Bay experiencing much reduced sediment flux as a result of the altered supply (Schoellhamer et al. 2007).

Average water quality concentrations of a variety of constituents for the Sacramento River and tributaries are shown in Appendix E, Table E-5. Most constituents are in relatively low concentrations; the river provides a high volume of relatively clean water to the Delta. The most downstream location, the Sacramento River at Freeport, has more elevated concentrations of nutrients and some metals, including mercury, than upstream tributaries.

Runoff, erosion, and remobilization of historical legacy pollutants (metals, organochlorines) as well as continued use of pesticides from urban and agricultural use are of concern in the Sacramento River watershed. The water quality of the mainstem Sacramento River is listed as degraded due to mercury and other heavy metals, with most of the contaminants mobilized with sediment transport during the winter months (Domagalski and Dileanis 2000). The lists of impaired water bodies identify the upper Sacramento River as impaired from mercury, copper, cadmium, and zinc. The Cache Creek drainages, Clear Lake, and the American River are listed as impaired due to mercury and methylmercury. Further water quality degradation and clean up or control efforts are focused on diazinon, chlorpyrifos, and other pesticides in Sacramento urban creeks, the Feather River, Sacramento River, and the Central Valley, in general (CVRWQCB 2009a). Rice pesticides are of particular concern, and these are monitored in rice field runoff as part of an ongoing program of the California Rice Commission (2005). See the full list of impaired water bodies in Appendix D, Regulatory Framework.

Waterborne selenium concentrations in the Sacramento River are relatively low (Table E-5). However, because of the much larger flow from the Sacramento River than from the San Joaquin River, the Sacramento River contributes substantially to the mass loading of selenium to the Delta (Cutter and Cutter 2004, p. 467; Presser and Luoma 2006, p. 36; San Francisco Bay RWQCB 2008, pp. 3-28, 3-29). Selenium concentrations in fillets and whole bodies of the bass from the Sacramento River at Veterans Bridge were well below the lowest benchmarks presented in Appendix D, Regulatory Framework (2.5 milligrams per kilogram (mg/kg) wet weight for fillets and 4.0 mg/kg dry weight in whole body) (Table E-2 and Figure E-1).

Largemouth bass fillets sampled for mercury revealed that the Sacramento River at River Mile 44 was one of the most elevated sites across the Delta for fish mercury, indicating the influence of upper Sacramento historical mining uses of mercury (Appendix E, Table E-3 and Figure E-2). Multiple species fish sampling results revealed the same general pattern of mercury bioaccumulation, with elevated mercury in fish found in the upper Sacramento and Feather Rivers (Melwani et al. 2009, pp. 6–12).

Dissolved organic carbon (DOC) compounds may serve as precursors to carcinogenic disinfection byproducts that degrade water quality. Urban runoff from the lower Sacramento River, through the Natomas East Main Drainage Canal into the lower American River, has indicated a relatively high loading of total organic carbon (TOC); at least 17 percent of the TOC in the Sacramento River downstream of Sacramento comes from a combination of Sacramento urban nonpoint source runoff (7 percent) and treated effluent discharge (10 percent), with a yield per area higher than that typically measured in rivers (Sickman et al. 2007). Mixing models indicate that the Sacramento River contributes approximately 50 percent of the DOC load to the SWP pumps, with agricultural drains contributing a third, and Delta algal growth the rest (Sickman et al. 2009).

Urban residential runoff contributes toxic amounts of pyrethroid insecticide residues to small streams and the American River, and pyrethroids were found in toxic levels in Sacramento municipal runoff (Weston and Lydy 2010, pp. 1835–1840).

3.3.4.1.3 Groundwater Hydrology

The Sacramento Valley overlies one of the largest groundwater basins in the state, and wells developed in the sediments of the valley provide excellent supply to irrigation, municipal, and domestic uses. Many of the mountain valleys within the region also provide significant groundwater supplies to multiple uses.

As agricultural land use and water demands have intensified over time, groundwater levels in certain areas have declined because increases in pumping have not been matched by increases in recharge. This condition has been the motivating force for development of supplemental surface supplies in a number of locales during the past 30 to 40 years, including Yolo County with its construction of Indian Valley Dam on the North Fork of Cache Creek, South Sutter Water District with its construction of Camp Far West Reservoir on the Bear River, and Yuba County, which constructed New Bullards Bar Dam and Reservoir on the North Yuba River.

Today, groundwater levels are generally in balance valley-wide, with pumping matched by recharge from the various sources annually. Some locales show the early signs of persistent drawdown, including the northern Sacramento County area, areas near Chico, and on the far west side of the Sacramento Valley in Glenn County where water demands are met primarily, and in some locales exclusively, by groundwater. These could be early signs that the limits of sustainable groundwater use have been reached in these areas.

Groundwater quality in the Sacramento Valley Groundwater Basin is generally good and sufficient for municipal, agricultural, domestic, and industrial uses. However, some localized groundwater quality problems exist. Natural groundwater quality is influenced by stream flow and recharge from the surrounding Coast Ranges and Sierra Nevada. Runoff from the Sierra Nevada is generally of higher quality than runoff from the Coast Ranges because of the presence of marine sediments in the Coast Ranges, and groundwater quality tends to be better in the eastern half of the Valley. Groundwater quality also varies from north to south, with the best water quality occurring in the northern portion of the Valley and poorer water quality in the southwestern portion (USGS 1984). In the southern half of the Valley, the TDS levels are higher because of the local geology, and large areas have TDS concentrations exceeding 500 mg/L. TDS concentrations as high as 1,500 mg/L have been reported in a few areas (USGS 1991). Areas that have high TDS concentrations include the south-central part of the Sacramento Valley Groundwater Basin, south of Sutter Buttes, in the area between the confluence of the Sacramento and Feather Rivers. The area west of the Sacramento River, between Putah Creek and the Delta, also has elevated TDS levels. The area around Maxwell, Williams, and Arbuckle has high concentrations of chloride, sodium, and sulfate (DWR 1978). TDS in this region averages about 500 mg/L, but concentrations exceeding 1,000 mg/L have been reported. The source of salinity in the Maxwell and Putah Creek areas is associated with mineral springs in the hills to the west. High salinity around the Sutter Buttes is believed to be caused by upwelling of saline water from underlying marine sediments (USGS 1984).

Nitrates found in groundwater have various sources, including fertilizer use, wastewater disposal, and natural deposits. Concentrations of nitrate as N exceeding 10 mg/L (which is the maximum contaminant level [MCL]) are found throughout the Central Valley; however, concentrations exceeding 30 mg/L as N are rare and localized. In the Sacramento Valley Groundwater Basin, the background nitrate concentration is estimated to be less than or equal to 3 mg/L. Two areas of elevated (greater than 5.5 mg/L) nitrate concentrations have been identified: one in northern Yuba and southern Butte counties (in the Gridley-Marysville area) and another in northern Butte and southern Tehama counties (in the

Corning-Chico area). Approximately 25 to 33 percent of samples from these areas have concentrations exceeding the MCL of 10 mg/L. Elevated nitrate concentrations in these areas are associated with shallow wells, and are thought to be the result of a combination of fertilizers and septic systems.

3.3.4.1.4 Water Use and Infrastructure

Water sources in the Sacramento River region are a mix of local, imported, groundwater, and water recycling and conservation. A significant amount of water is local runoff captured in reservoirs as well as water from the SWP and CVP. Table 3-1 provides a summary of water supplies in the region.

Table 3-1
Water Supplies in the Sacramento River Watershed

Water Supply Source	Water Supply (Thousand Acre-Feet)							
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Surface water	13,939.5	8,758.5	12,204.8	8,843.0	4,799.8	5,853.9	6,741.9	8,256.0
Local deliveries	9.7	51.9	10.4	8.5	11.0	7.8	15.0	6.2
CVP base and project deliveries	1,990.7	2,383.8	2,466.7	2,497.3	4,617.8	4,350.1	4,631.9	4,131.1
Other federal deliveries	198.0	269.3	228.3	239.5	247.0	208.2	258.4	190.9
SWP deliveries	14.9	15.4	14.9	19.6	20.1	3.8	24.5	25.1
Groundwater pumping	1,854.7	2,672.7	2,815.2	2,926.9	2,569.6	2,473.0	2,923.7	2,445.7
Return flow from carryover storage	0.0	0.0	0.0	0.0	120.5	104.1	116.8	111.4
Reuse/recycle								
Reuse surface water	5,575.8	10,609.3	5,320.8	4,497.2	8,952.4	9,893.0	9,036.5	8,345.6
Recycled water	0.0	97.8	0.0	0.0	0.2	0.2	0.2	0.2
Total supplies	23,583	24,859	23,061	19,032	21,338	22,894	23,749	23,512

Source: DWR 2009a

Surface Water Use

Surface water supplies within the Sacramento River watershed include CVP, SWP, Settlement Contractor, and water rights deliveries to meet demands on the Sacramento, Feather, and American Rivers. The CVP has 253 water service contracts (including Sacramento River Settlement Contracts). These water service contracts have had varying water shortage provisions. There will be a minimum shortage allocation for municipal and industrial water supplies of 75 percent of a contractor’s historical use.

Shasta Dam and Reservoir are the CVP’s largest; these facilities are operated for water storage and flood control for the Sacramento River. Shasta Reservoir stores water for controlled releases downstream. Water released from Shasta Dam flows downstream toward the Delta, providing for irrigation and municipal uses in Sacramento and the Bay Area.

The CVP operates Folsom Lake to make deliveries to CVP municipal and industrial water service contractors and water rights holders along the American River. Water rights holders include riparian water rights that have contracts with the CVP to deliver the water right amount.

Folsom Lake has a capacity of nearly 1 MAF. Releases from Folsom Dam are re-regulated approximately 7 miles downstream by Nimbus Dam. Other upstream storage is provided by five reservoirs: French Meadows (136,000 acre-feet per year), Hell Hole (208,000 acre-feet per year), Loon Lake (76,000 acre-feet per year), Union Valley (277,000 acre-feet per year), and Ice House (46,000 acre-feet per year). French Meadow and Hell Hole reservoirs, located on the middle fork of the American River, are owned and operated by Placer County Water Agency.

The SWP operates Lake Oroville to make deliveries to SWP water service contractors and Feather River Service Area contractors in the Feather River system. The Feather River Service Area contractors are water users who hold riparian and senior appropriative rights on the Feather River. The State entered into contractual agreements with these existing water rights holders to establish the quantity of water the contractor is permitted to divert under independent senior water rights on a monthly basis and outline supplemental SWP supply allocated by the State (Reclamation 1997, p. III-25).

Lake Oroville has a capacity of about 3.5 MAF (DWR 2010a, p.15). Releases from Lake Oroville are regulated downstream on the Feather River at Thermalito Afterbay. Four major diversions take water at the Thermalito Afterbay: Western Canal, Richvale Canal, the Pacific Gas and Electric Company (PG&E) Lateral, and the Sutter-Butte Canal. Some of the water diverted into these canals is exported to the Butte Creek watershed.

The Anderson-Cottonwood Irrigation District maintains a diversion dam across the Sacramento River near Redding, which is used to divert water into the district's canal for irrigation along the west sides of the Sacramento River between Redding and Cottonwood. The Red Bluff Diversion Dam is located approximately 2 miles south of the City of Red Bluff and diverts water from the Sacramento River into the Tehama-Colusa and Corning canals. The Glenn-Colusa Irrigation District supplies water from the Sacramento River near Hamilton City.

Environmental Water Use

The Sacramento River is the largest riverine ecosystem in California and provides essential habitat for many anadromous fish populations—such as Chinook salmon and steelhead—for their spawning, holding, and rearing requirements. In many areas of the Sacramento River watershed, the rivers and streams have in-stream structures that prevent fish passage and even harm aquatic life. A wide variety of CVP operation modifications and structural repairs has been implemented to benefit wildlife and anadromous fish resources in compliance with the Anadromous Fish Restoration Program, Anadromous Fish Screening Program, and the CVPIA. Operational improvements include fish screening and recovery facilities, structural changes in CVP facilities, and mandated changes in water operations to support fisheries restoration through a combination of timed increases in flows; water banking, conservation, and transfers; and modified operations and new or improved control structures (DWR 2009a, p. SR-12). More details are provided in the preceding Delta and Suisun Marsh discussion and in Appendix D, Regulatory Framework.

Groundwater Use

Approximately 31 percent of the region's urban and agricultural water needs are met by groundwater (DWR 2003, p. 159). Although surface water supplies provide the majority of water used by the Sacramento Valley's agricultural sector, groundwater provides approximately 10 to 15 percent of the total water used to support agricultural uses, depending on water year type.

Municipal, industrial, and agricultural water demands in the region total approximately 8 MAF, and groundwater provides about 2.5 MAF of this total. The portion of the water diverted for irrigation but not actually consumed by crops or other vegetation becomes recharge to the groundwater aquifer or flows back to surface waterways and contributes to surface supplies either within or downstream of the Sacramento Valley.

Water Recycling and Water Conservation

Currently, recycled water use occurs in urban areas or agricultural land near wastewater treatment plants. The Sacramento Regional County Sanitation District has formed the Sacramento Water Recycling Coalition and currently produces about 3.5 mgd of recycled water supply, with possible additional development in the future (Sacramento Regional County Sanitation District 2011). Other water recycling projects have been developed by the cities of Redding and Davis and by El Dorado Irrigation District (EDID). The City of Redding recycles 9.21 acre-feet of water per year. This water is supplied to irrigation users and for washdown and landscape water at the wastewater treatment plant. Davis currently supplies water to 180 acres of City-owned reclamation wetlands with approximately 1,170 acre-feet per year of secondary treated effluent. The EDID has dual plumbing for recycled water in highway medians, golf courses, landscaping, and at 1,600 homes in its service area. The EDID produces over 1 billion gallons per year of recycled water (EDID 2010).

Water Exports and Transfers

A significant portion of the water from the Sacramento River watershed is transported through the Delta for use in other areas: the San Joaquin Valley (including Tulare Lake), Bay Area, Central Coast, and South Coast regions. The SWP operates Lake Oroville on the Feather River for releases to SWP contractors off the North Bay Aqueduct and for south-of Delta contractors through Banks Pumping Plant. The CVP operates Shasta Lake on the Sacramento River and Folsom Lake on the American River to release water for CVP contractors that is pumped south of the Delta through Jones Pumping Plant and excess capacity in Banks Pumping Plant.

In the early 2000s, several dry-year transfer programs were developed in response to drought in Southern California and low prices for farm commodities (Howitt and Hanak 2005), including the 2001 “forbearance program” of the CVP contractors, which moved water from Sacramento Valley water users to the Westlands Water District. Metropolitan Water District of Southern California (Metropolitan) has also played a leading role in dry year transfer arrangements to secure more reliable supplies in its extensive and highly urbanized service area. Participating irrigators have switched to less water-intensive crop production and use of groundwater to make surface water available for transfer to other users. Water transfers to Southern California occur on a year-by-year basis, with contracts developed early during the year (around February) before the rainy season is over and the Sacramento Valley irrigation season has started. Transfers are then exercised depending on hydrologic conditions, projected water demands, and whether mechanisms to transfer water through the Delta are available.

More recently, the DWR has facilitated water transfer programs that are a combination of drought water banks and groundwater substitution water transfers. Groundwater substitution water transfer programs were conducted in 2008 and 2010, while a drought water bank program transferring water was conducted in 2009.

3.3.4.2 San Joaquin River Watershed

The San Joaquin River watershed includes a drainage area extending south from the southern boundaries of the Delta to include the northern drainage of the San Joaquin River in Madera County and its southern drainage in Fresno County. The watershed is hydrologically separated from the Tulare Lake watershed by a low, broad ridge that extends across the San Joaquin Valley between the San Joaquin and Kings rivers. Its eight major tributaries drain about 32,000 square miles of watershed, roughly from Fresno to Stockton (DWR 2009a, p. SJ-3).

The San Joaquin River watershed experiences a wide range of precipitation that varies from low rainfall amounts on the valley floor to extensive snowfall in the higher elevations of the Sierra Nevada. The average annual precipitation of several Sierra Nevada stations is about 35 inches. Snowmelt from the mountains is a major contributor to local eastern San Joaquin Valley water supplies. Average annual precipitation ranges from about 22 inches near Stockton in the north to about 11 inches in the southern portion; it decreases to about 6.5 inches near the drier southwestern corner of the watershed (DWR 2009a, p. SJ-6-7).

3.3.4.2.1 Surface Water Hydrology

The primary sources of surface water to the basin are rivers that drain the western slope of the Sierra Nevada. Each of these rivers (the San Joaquin, Fresno, Chowchilla, Merced, Tuolumne, Stanislaus, Calaveras, Mokelumne, and Cosumnes) drains large areas of high elevation watershed that supply snowmelt runoff during the late spring and early summer months. Historically, peak flows occurred in May and June, and flooding occurred in most years along all of the major rivers. The San Joaquin River originates in the Sierra Nevada at an elevation over 10,000 feet and flows into the San Joaquin Valley at Friant Dam in the Sierra Nevada foothills north of Fresno. The river then flows to the center of the valley floor, where it turns sharply northward and flows through the San Joaquin Valley to the Delta. Along the valley floor, the San Joaquin receives additional flow from the Fresno, Chowchilla, Merced, Tuolumne, and Stanislaus rivers. The three northernmost streams, the Calaveras, Mokelumne, and Cosumnes Rivers, flow into the San Joaquin River within the boundaries of the Delta (Reclamation 1997, p. III-6).

Flows in the upper San Joaquin River are regulated by the CVP's Friant Dam, which was completed in 1941 to store and divert water to the Madera and Friant-Kern canals for irrigation and municipal and industrial water supplies in the eastern portion of the San Joaquin Valley. Millerton Lake, formed by Friant Dam, has a capacity of 520,000 acre-feet. Above Friant Dam, the San Joaquin River drains an area of approximately 1,676 square miles. Several reservoirs in the upper portion of the San Joaquin River watershed, including Edison, Florence, Huntington, Mammoth Pool, and Shaver Lake, are primarily used for hydroelectric power generation. The operation of these reservoirs affects the inflow to Millerton Lake. In the reach between Friant Dam and Gravelly Ford, flow is influenced by releases from Friant Dam, with minor contributions from agricultural and urban return flows. Releases from Friant Dam are generally limited to those required to satisfy downstream water rights and in-stream flows (Reclamation 1999, p. 3-7). The operation of the dam ceased flow in portions of the river downstream of Gravelly Ford, except for flood flow releases. The San Joaquin River Restoration Program comprises several Federal and State of California agencies currently working to return flows to the river and restore and maintain fisheries in "good condition" in the main stem San Joaquin River below Friant Dam to the confluence with the Merced River. Implementing agencies include Reclamation, USFWS, NMFS, DWR, and California Department of Fish and Game.

Flows entering the Delta from the San Joaquin River at Vernalis are affected by the operation of upstream facilities on the San Joaquin, Merced, Tuolumne, and Stanislaus rivers, and by deliveries to the Mendota Pool from the Delta-Mendota Canal and flows from the Kings River in the Tulare Lake watershed. Prior to the construction of major dams on the San Joaquin River and its tributaries, average monthly flows peaked during May and June as a consequence of snowmelt runoff. Unrestricted flows have not occurred since the construction of the original Exchequer and Don Pedro reservoirs in the 1920s. Between 1941 and 1978, flows were altered from natural conditions because of operations at Friant, New Exchequer, New Don Pedro, and New Melones dams. New Melones Dam, the most recently constructed dam in the San Joaquin River Basin, was completed in 1978. Since that time, average monthly flows in the San Joaquin River at Vernalis have been more uniform throughout the year, with maximum flows less than historical levels (Reclamation 1999, p. 3-9). Streams on the west side of the San Joaquin Watershed are intermittent, and their flows rarely reach the San Joaquin River. Natural runoff from sloughs in the western portion of the watershed is augmented with agricultural drainage (Reclamation 1997, p. III-8).

The Fresno River receives water from the lower elevations of the Sierra Nevada foothills. Most of the runoff comes directly from rainfall. Flow in the river is regulated by Hidden Dam, which forms Hensley Lake with a capacity of 90 thousand acre-feet.

The Chowchilla River flows approximately parallel to Fresno River out of the Sierra Nevada foothills and flows into the San Joaquin River past the City of Chowchilla. The river is regulated downstream of the Buchanan Dam, which holds approximately 150,000 acre-feet of water in Eastman Lake.

The Merced River originates in the Sierra Nevada and drains an area of approximately 1,273 square miles east of the San Joaquin River. Agricultural development in the Merced River watershed began in the 1850s, and significant changes have been made to the hydrologic system since that time. The enlarged New Exchequer Dam, forming Lake McClure with a capacity of just over 1 MAF, was completed in 1967 and now regulates releases to the lower Merced River. New Exchequer Dam is owned and operated by the Merced Irrigation District for power production, irrigation, and flood control. Releases from Lake McClure pass through a series of power plants and smaller diversions and are reregulated at McSwain Reservoir. Below McSwain Dam, water is diverted to Merced Irrigation District at the PG&E Merced Falls Dam and farther downstream at the Crocker Huffman Dam (Reclamation 1999, p. 3-8).

The Tuolumne River originates in the Sierra Nevada and drains a watershed of approximately 1,540 square miles. Flows in the lower portion of the Tuolumne River are controlled primarily by the operation of New Don Pedro Dam, which was jointly constructed in 1971 by Turlock Irrigation District and Madera Irrigation District with participation by the City and County of San Francisco. The 2.03 MAF reservoir stores water for irrigation, hydroelectric generation, fish and wildlife enhancement, recreation, and flood control purposes. The districts divert water to the Modesto Main Canal and the Turlock Main Canal a short distance downstream from New Don Pedro Dam at La Grange Dam. The existing dam at La Grange was completed in 1893. The San Francisco Public Utilities Commission (SFPUC) operates several water supply and hydroelectric facilities within the Tuolumne River Basin upstream of New Don Pedro Reservoir. O’Shaughnessy Dam on the main stem of the Tuolumne River, completed in 1923, impounds approximately 0.36 MAF of water in Hetch Hetchy Reservoir. Water from Hetch Hetchy is used primarily to meet the municipal and industrial water needs of the SFPUC and to provide in-stream flows in the Tuolumne River below O’Shaughnessy Dam. Two other storage facilities upstream of New Don Pedro Reservoir, Lake Eleanor and Cherry Lake, are also operated by SFPUC for hydropower and water supply purposes. The combined capacity of these two reservoirs is about 0.3 MAF (Reclamation 1999, p. 3-9).

The Stanislaus River originates in the Sierra Nevada and drains a watershed of approximately 900 square miles. Snowmelt runoff contributes the largest portion of the flows in the Stanislaus River, with the highest monthly flows in April, May, and June. Flow control in the lower Stanislaus River is provided by the New Melones Reservoir, which has a capacity of 2.4 MAF and is operated by Reclamation as part of the CVP. Releases from New Melones Reservoir are re-regulated downstream by Tulloch Reservoir. Releases from Tulloch Powerhouse flow downstream to Goodwin Dam, where diversions are made into the Oakdale and South San Joaquin canals. More than 40 small pump diversions along the Stanislaus River supply irrigation water during spring and summer. Goodwin Dam is used to divert water into the Goodwin Tunnel for deliveries to Central San Joaquin Water Conservation District and the Stockton East Water District. Stockton East Water District has a contract with Reclamation for 75 thousand acre-feet of water per year of New Melones water to be delivered from Tulloch Reservoir through the Goodwin Tunnel/Farmington Canal system, when available (Reclamation 1999, p. 3-10). The Calaveras River originates in the Sierra Nevada and drains an area of approximately 363 square miles. It enters the San Joaquin River near the City of Stockton. The Calaveras River watershed is almost entirely below the effective average snowfall level (5,000 feet) and receives nearly all of its flow from rainfall. As a result, nearly all of the annual flow occurs between December and April. The major water management facility on the Calaveras River is New Hogan Dam and Lake (constructed in 1963 by the USACE), which has a storage capacity of 0.3 MAF and is operated by USACE and Stockton East Water District (Reclamation 1997, p. III-10).

The Mokelumne River originates in the Sierra Nevada and drains a watershed of approximately 661 square miles. It is a major tributary to the Delta, entering the lower San Joaquin River northwest of Stockton. Three major reservoirs influence stream flow in the Mokelumne River. The uppermost, Salt Springs Reservoir, is owned by PG&E and is on the North Fork of the Mokelumne River. It has a storage capacity of 141,900 acre-feet and began operation in 1963. Pardee and Camanche reservoirs are on the main stem of the Mokelumne and are both owned and operated by EBMUD. Pardee, completed in 1929, has a storage capacity of 209,900 acre-feet. Camanche Reservoir, with a storage capacity of 430,800 acre-feet, is downstream of Pardee Dam.

Water is exported from the Mokelumne River watershed to the EBMUD service area via the Mokelumne River Aqueduct, which receives water directly from Pardee Reservoir. Water is released from Camanche Reservoir to maintain downstream water requirements and to provide flood protection on the Mokelumne River. Other than the Mokelumne Aqueduct diversion, the most significant diversion in the watershed occurs at Woodbridge Dam, which diverts water into the Woodbridge Canal for irrigation of land south and west of the town of Woodbridge (Reclamation 1997, p. III-10).The Cosumnes River originates in the lower elevations of the Sierra Nevada and drains a watershed of approximately 537 square miles. It enters the Mokelumne River in the Delta near Thornton. Because of the low elevation of its headwaters, the Cosumnes River receives most of its water from rainfall. The only major water supply facilities in the Cosumnes River watershed are components of the Sly Park Unit of the CVP. The water supply provided by the Sly Park Unit is used by EDID and is not integrated into the CVP operations (Reclamation 1997, p. III-10).

3.3.4.2.2 Surface Water Quality

The San Joaquin River and tributaries come from the Sierra Nevada and contribute relatively unpolluted water sources to the Delta and valley. However, the streams are highly controlled and managed and used extensively for agriculture and municipal uses. The resulting agricultural drainage is of significantly degraded quality (salinity, nutrients, pesticides, selenium, suspended sediment) as compared to the source waters (Central Valley RWQCB 2009b). Average water quality concentrations of a variety of constituents for the San Joaquin River and tributaries are provided in Appendix E, Tables E-6 and E-7, respectively. Impaired water bodies and response actions are listed in Appendix D, Regulatory Framework.

Salts are a major concern in the San Joaquin Valley, and the Central Valley RWQCB has adopted a TMDL for the San Joaquin River upstream of Vernalis for salt and boron (Central Valley RWQCB 2007a). The Central Valley RWQCB implemented the comprehensive salt management program, known as the Central Valley Salinity Alternatives for Long Term Sustainability (CV-SALTS), to develop salt control strategies for the San Joaquin and the entire Central Valley watershed (Central Valley RWQCB 2007a, Larry Walker Associates 2010). Subsequently, the SWRCB initiated development of flow and salinity objectives for the San Joaquin River as part of development of the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan).

The eastside streams flow directly to the Delta and consist of the Cosumnes, Mokelumne, and Calaveras. Average water quality concentrations of a variety of constituents for the eastside streams are shown in Appendix E, Table E-8). These streams drain the northern Sierra Nevada and provide relatively unpolluted water sources to the Delta. Some exceptions result from urban and agricultural runoff and historical mining pollution, including mercury. The eastside streams have been monitored as part of the Regional Water Boards San Joaquin Basin Rotational Sub-basin Monitoring program. In general, the streams did not show evidence of impairment for water supply, aquatic life, or recreation (Central Valley RWQCB 2009b). Results from 2002 displayed distinct spatial and seasonal patterns. Temperature, DO, and pH displayed typical patterns, and other constituents (TOC, bacteria, and electrical conductivity

[EC])[5] were greatly influenced by storm flows. The Cosumnes exhibited the greatest toxicity and highest suspended solids, the Mokelumne had the highest TOC, and the Calaveras had the highest EC.

The Cosumnes and Mokelumne stand out as being areas with some of the highest levels of bioaccumulated mercury in the Delta watershed. Fish tissue monitoring throughout the Delta and its tributaries revealed that across and within species, fish mercury was most elevated at these two rivers. Largemouth bass was the most contaminated species and provided broad spatial comparisons throughout the Delta (Melwani et al. 2009, pp. 6–12). This pattern is seen in Appendix E, Table E-3 and Figure E-2.

Another exception to the relative lack of pollution of eastside streams in the San Joaquin watershed is that the lower Calaveras River is the subject of multiple TMDLs for impairment due to pesticides, low DO, and pathogens (LeBay et al. 2008) (Appendix D, Regulatory Framework). Pesticides and DO are being addressed under San Joaquin and Delta TMDLs. Pathogens are the subject of cleanup programs related to MS4 (municipal stormwater permits) and permitted National Pollutant Discharge Elimination System (NPDES) wastewater discharges under a separate pathogens TMDL, with best management practices (BMPs) currently under development (LeBay et al. 2008).

In the San Joaquin watershed, selenium is particularly enriched in marine sedimentary rocks of the Coast Ranges on the western side of the San Joaquin Valley, soils derived from those rocks, and irrigation drainage from those lands (Presser and Piper 1998, p. 153). It is highly bioaccumulative, and is of greatest concern because it can cause chronic toxicity (especially impaired reproduction) in fish and aquatic birds and also may adversely affect human health (OEHHA 2008, pp. 32; Ohlendorf 2003, p. 490; San Francisco Bay RWQCB 2011).

The Central Valley RWQCB completed a TMDL for selenium in the lower San Joaquin River (downstream of the Merced River) in 2001, and the U.S. Environmental Protection Agency (USEPA) approved it in 2002 (Central Valley RWQCB 2011a). Other selenium TMDLs for the watershed include one for Salt Slough (approved by USEPA in 1999) and for the Grasslands Marshes (approved by USEPA in 2000) (Central Valley RWQCB 2011b and 2011c). These TMDLs are implemented primarily through prohibitions of discharge of agricultural subsurface drainage water. In 2010, the Central Valley RWQCB and SWRCB approved amendments (Resolution 2010-0046) to the WQCP for the Sacramento River and San Joaquin River Basins to address selenium control in the San Joaquin River basin as related to the Grassland Bypass Project (which is described below) (Central Valley RWQCB 2010b, SWRCB 2010b).

Selenium is monitored frequently in the San Joaquin River watershed, in part because agricultural drainage in the San Joaquin Valley is a primary source of selenium to the Delta (Presser and Luoma 2006, pp. 1–2; Entrix 2008, p. ES-2; San Francisco Bay RWQCB 2008, p. 1-1) and selenium concentration data for the river at Hills Ferry and at Vernalis during 1999 and 2000 are presented in Appendix E, Tables E-6 and E-7. The differences between the stations highlight the source of selenium from the Grasslands area. Selenium concentrations are higher at Hills Ferry (maximum of 11 micrograms per liter [µg/L], mean of 3.9 µg/L) than at Vernalis (maximum of 2.8 µg/L, mean of 0.9 µg/L) Hills Ferry is downstream of the Grassland Bypass Project discharge to the San Joaquin River, where it is monitored weekly by the Grassland Area Farmers (SFEI 2011a, p. 4).

Mercury, pesticides, and legacy organochlorine contaminants are an ongoing water quality concern in some San Joaquin drainage areas dominated by runoff from agriculture. For example, small westside tributaries, such as Orestimba Creek, may carry a wide variety of herbicides, polycyclic aromatic hydrocarbons, and older, banned pesticides like DDTs. The chemicals are primarily carried in suspended sediment during high flows and contribute to uptake of contaminants in the tissues of resident aquatic biota (Pereira et al. 2008). Studies by USGS in the 1990s discovered that the San Joaquin River and its tributaries were impacted by pesticides through seasonal applications and runoff as well as erosion of

[5] EC is directly related to salinity by a simple site-specific factor conversion. Higher EC means higher salinity.

legacy organochlorine pesticides (Dubrovsky et al. 1998, pp 1–6). Runoff of pyrethroid pesticides has been at high enough concentrations in the San Joaquin River to cause toxicity (Weston and Lydy 2010, pp. 1838–1839). In contrast, nutrients are not at high enough concentrations in runoff to be of concern to beneficial uses (Dubrovsky et al. 1998, pp. 1–6).

Bioaccumulative chemicals in the San Joaquin drainage have resulted in fish advisory listings for mercury and PCB concentrations in sport fish in the river reach from Friant Dam to the Port of Stockton (OEHHA 2007). The largemouth bass from the San Joaquin River at Vernalis were among the most elevated in fillet mercury concentrations across the Delta region (Appendix E, Table E-3 and Figure E-2). Selenium presents a bioaccumulative risk, but concentrations in fillets and whole bodies of largemouth bass from the San Joaquin River at Fremont Ford, Crows Landing, and Vernalis (Appendix E, Table E-2 and Figure E-1) were well below the lowest benchmarks presented in Appendix D, Regulatory Framework (2.5 mg/kg wet weight for fillets and 4.0 mg/kg dry weight in whole body).

3.3.4.2.3 Groundwater Hydrology

The San Joaquin River watershed overlies portions of nine groundwater subbasins as defined by DWR: the Cosumnes, East San Joaquin, Tracy, Delta-Mendota, Modesto, Turlock, Merced, Chowchilla, and Madera subbasins (DWR 2003, p. 169) (Figure 3-5). The Tracy subbasin is almost entirely located in the Delta, and is therefore not discussed again in this section. The San Joaquin River watershed is marked by laterally extensive deposits of thick fine-grained materials deposited in lacustrine and marsh depositional systems. These units, which can be tens to hundreds of feet thick, create vertically differentiated aquifer systems within the subbasin. The Corcoran Clay (or E-Clay), occurs in the Tulare Formation and separates the alluvial water-bearing formations into confined and unconfined aquifers. The direction of groundwater flow generally coincides with the primary direction of surface water flows in the area, which is to the northwest toward the Delta. Groundwater well yields in the San Joaquin River watershed typically range from 300 to 2,000 gpm for the deeper aquifers underlying the Corcoran clay (DWR 2003 p. 169). Groundwater levels fluctuate seasonally and a strong correlation exists between depressed groundwater levels and periods of drought, when the area pumps more groundwater to support agricultural operations.

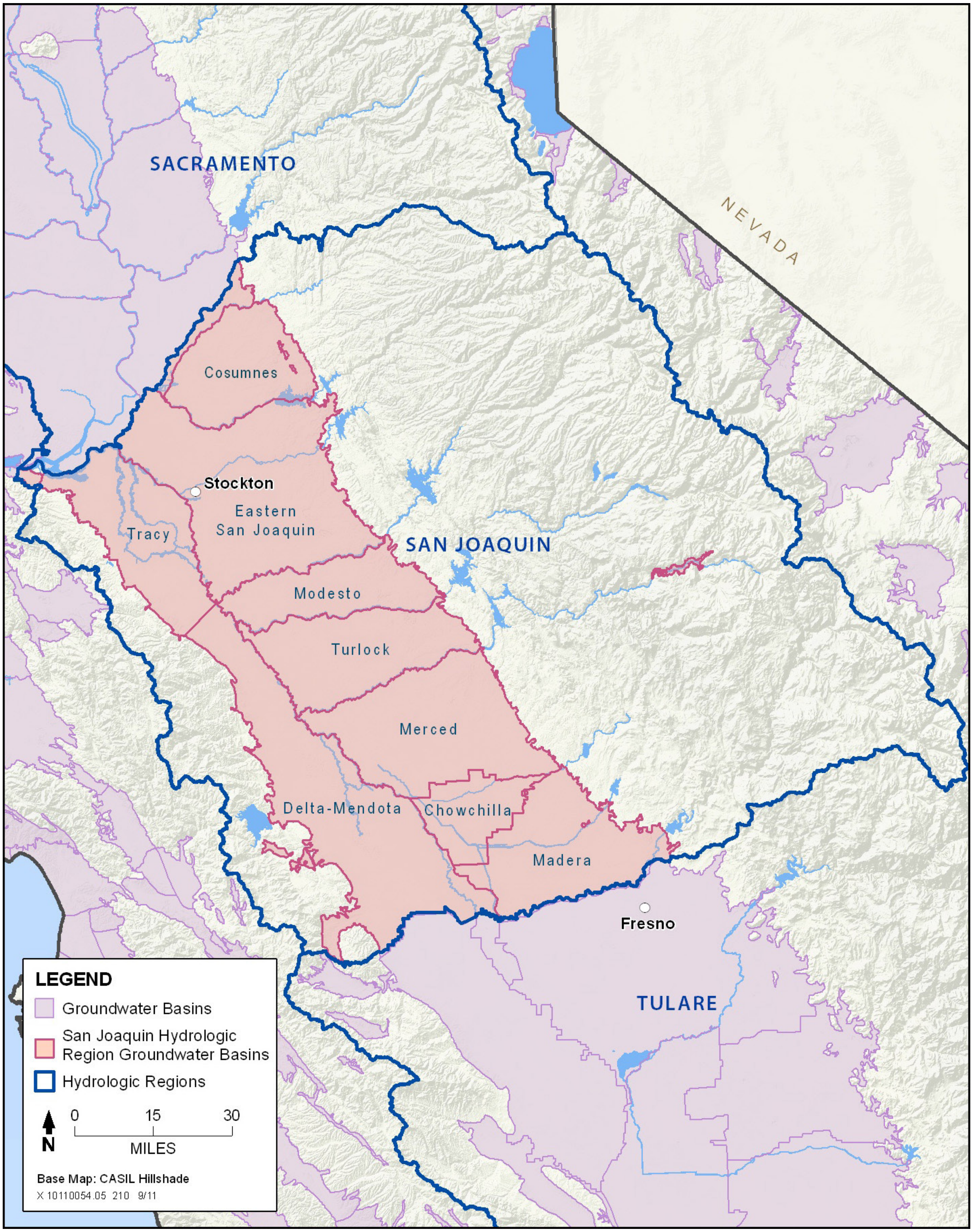
Groundwater levels in the Cosumnes subbasins have fluctuated over the past 40 years, with the lowest levels occurring during periods of drought. From 1987 to 1995, water levels declined by about 10 to 15 feet and then recovered by the same amount until 2000. Areas affected by municipal pumping show a lower groundwater level recovery than in other areas (DWR 2006c, p. 2). The groundwater storage capacity of the Cosumnes subbasin is estimated at approximately 6 MAF. The Cosumnes subbasin contains groundwater of very good quality, and DWR has not identified any significant impairments (DWR 2006c, p. 3). TDS levels range from 140 to 438 mg/L and average about 218 mg/L based on the analysis of samples from 20 water supply wells (DWR 2006c, p. 3).

Groundwater levels in the East San Joaquin subbasin have continuously declined in the past 40 years due to groundwater overdraft. Cones of depression are present near major pumping centers such as City of Stockton and City of Lodi (DWR 2006a, p. 3). Groundwater level drops of up to 100 feet have been observed in some wells. In the 1990s, groundwater levels were so low that many wells were inoperable and many groundwater users were obligated to construct new deeper wells (NSJCGBA 2004, p. 6). The groundwater storage capacity of the East San Joaquin subbasin is estimated at approximately 42.2 MAF (DWR 2006a).

Figure 3-5

Groundwater Basins in the San Joaquin Watershed

Source: DWR 2003



In the Eastern San Joaquin subbasin, TDS levels range widely between 50 and 3,520 mg/L. The high groundwater salinity is attributed to poor-quality groundwater intrusion from the Delta caused by the decline of groundwater levels. This saline groundwater front has been particularly apparent in the groundwater underlying the Stockton area. High chloride concentrations have also been observed in well water in the Eastern San Joaquin subbasin, as described previously in the Delta section.

Groundwater conditions in the six subbasins that completely underlie the San Joaquin River watershed (excluding the eastside streams area) are summarized with the groundwater budgets presented in Table 3-2. The data provide approximate annual estimates of groundwater budgets made by DWR.

Table 3-2
Annual Groundwater Budget Components for Selected Subbasins in the San Joaquin River Watershed

Groundwater Budget Components	Acre-feet per Year (average)					
	Delta-Mendota Subbasin	Modesto Subbasin	Turlock Subbasin	Merced Subbasin	Chowchilla Subbasin	Madera Subbasin
Recharge from precipitation and surface water	8,000	86,000	33,000	47,000	87,000	21,000
Recharge from applied water	74,000	92,000	313,000	243,000	179,000	404,000
Subsurface inflow	—	—	—	—	—	—
Groundwater pumping	511,000	226,000	452,000	546,000	255,000	566,000
Evapotranspiration	—	—	—	—	—	—
Subsurface outflow	—	—	—	—	—	—

Source: DWR 2006d, 2004c, 2006c, 2004d, 2004e, 2004f
—: not determined

Even though subsurface inflows and outflows have not been determined, these numbers indicate that several subbasins pump more groundwater from the aquifers than is recharged, which might result in areas of overdraft. The main source of groundwater recharge is from applied irrigation water, and groundwater pumping largely exceeds this replenishment source. In the Delta-Mendota subbasin, groundwater levels have generally declined by as much as 20 feet in the northern portion of the basin near Patterson between 1958 and 2006; the southern portion remained fairly constant during that same time (see Figure E-3, Appendix E). A more recent trend shows that groundwater levels have generally increased since the 1970s (DWR 2006d, p. 2).

In the Modesto subbasin, water levels have declined nearly 15 feet on average between 1970 and 2000 (DWR 2004c, p. 3), with the major declines occurring in the eastern portion of the subbasin. Between 1958 and 2006, groundwater levels have declined by as much as 30 feet in the western portion of the basin, near the City of Modesto (see Figure E-4, Appendix E).

In the Turlock subbasin, water levels have declined nearly 7 feet on average from 1970 through 2000 (DWR 2006e, p. 2). Comparison of groundwater contours from 1958 and 2006 shows that historically, groundwater flows occurred from east to west, toward the San Joaquin River. Groundwater pumping centers to the east of the City of Turlock have drawn the groundwater toward these cones of depression, allowing less water to flow toward the San Joaquin River, diminishing the groundwater discharge to the river. Between 1958 and 2006, groundwater levels have declined by as much as 30 feet in the eastern portion of the basin, near the City of Turlock (see Figure E-5, Appendix E).

In the Merced subbasin, water levels have declined nearly 30 feet on average from 1970 through 2000. Water level declines have been more severe in the eastern portion of the subbasin (DWR 2004d, p. 2). Between 1958 and 2006, groundwater levels have declined by as much as 40 feet in the eastern portion of the basin, near the City of Merced (see Figure E-6, Appendix E).

In the Chowchilla subbasin, water levels have declined nearly 40 feet on average from 1970 through 2000. Water level declines have been more severe in the eastern portion of the subbasin from 1980 to present, but the western basin showed the strongest declines before this period (DWR 2004e, p. 2). Between 1958 and 2006, groundwater levels have declined by more than 100 feet in the eastern portion of the basin, near the City of Chowchilla, and by more than 50 feet in the western portion of the subbasin (see Figure E-7, Appendix E).

In the Madera subbasin, water levels have declined nearly 40 feet on average from 1970 through 2000. Water level declines have been more severe in the eastern portion of the subbasin from 1980 to the present, but the western subbasin showed the strongest declines before this period (DWR 2004f, p. 2). Between 1958 and 2006, groundwater levels have declined by more than 100 feet in most parts of the subbasin (see Figure E-8, Appendix E).

The groundwater in the San Joaquin River subbasins is generally of suitable quality for most urban and agricultural uses with only local impairments. As shown in the summary table below (Table 3-3) the primary constituents of concern are TDS, nitrate, iron, boron, chloride, and organic compounds (DWR 2003, p. 170).

Table 3-3
Groundwater Quality in the San Joaquin River Watershed South of the Delta

Groundwater Quality Components	Delta-Mendota Subbasin	Modesto Subbasin	Turlock Subbasin	Merced Subbasin	Chowchilla Subbasin	Madera Subbasin
Water type	Mixed sodium to bicarbonate; sodium chloride; sodium sulfate	Calcium carbonate; calcium-magnesium bicarbonate; calcium-sodium bicarbonate	Mostly sodium-calcium bicarbonate	Mostly calcium-magnesium bicarbonate, sodium bicarbonate, calcium-sodium bicarbonate	Calcium-sodium Bicarbonate; calcium bicarbonate; sodium-calcium bicarbonate; sodium chloride	Calcium sodium bicarbonate; sodium bicarbonate; sodium chloride
TDS ranges (mg/L)	400 to 6,600	60 to 8,300	100 to 8,300	100 to 3,600	120 to 6,400	100 to 6,400
Impairments	Saline groundwater within 10 ft of ground surface; localized areas of high iron, fluoride, nitrate, and boron	Localized areas of high chloride, boron, DBCP, nitrate, iron, and manganese	Localized areas of high nitrate, chloride, boron, and DBCP	Localized areas of iron, nitrate, and chloride	Localized areas of high nitrate, iron, and chloride	Localized areas of high iron, nitrate, and chloride

Source: DWR 2006d, 2004c, 2006c, 2004d, 2004e, 2004f

DBCP: dibromochloropropane (chemical compound found in pesticides)

Localized groundwater contamination includes industrial organic contaminants such as trichloroethylene (TCE), dichloroethylene, and other solvents. They can be found in groundwater near airports, industrial areas, and landfills (DWR 2003, p. 170).

Surface water and groundwater are hydraulically connected in most areas of the San Joaquin River and tributaries. Historically, groundwater actively discharged to streams in most of this watershed. After the 1950s, increased groundwater pumping in the area lowered groundwater levels and reversed the hydraulic gradient between the surface water and groundwater systems, resulting in surface water recharging the underlying aquifer system through streambed seepage. Long-term groundwater production throughout this basin has lowered groundwater levels beyond what natural recharge can replenish. Areas where this has occurred include eastern San Joaquin and Merced counties and western Madera County. This is especially true in the Gravelly Ford area, where the riverbed is highly permeable and river water readily seeps into the underlying aquifer. In the northern portions of the San Joaquin River, groundwater levels are shallow and groundwater discharges into the river.

3.3.4.2.4 Water Use and Infrastructure

Water used in the San Joaquin River watershed includes a mixture of San Joaquin River water, local runoff, groundwater, and imported water supplies. Table 3-4 shows the water supply sources for the San Joaquin River watershed from 1998 to 2005 (DWR 2009a). On average, between 1998 and 2005, 34 percent of the water supply consisted of local surface water deliveries to water rights holders in the watershed. Surface water reuse, predominantly from agricultural runoff, also provided a significant amount of water to downstream users in the watershed and accounted for 27 percent of the watershed's water supply. Groundwater accounted for 24 percent of the supply, and CVP water imported from the Delta accounted for another 15 percent. A minor amount was also provided by other supplies such as SWP imports, drainage from other watersheds, recycled water, and other federal deliveries.

Table 3-4
Water Supplies in the San Joaquin River Watershed

Water Supply Source	Water Supply (Thousand Acre-Feet)							
	1998	1999	2000	2001	2002	2003	2004	2005
Surface Water								
Local deliveries	3,229.8	4,001.5	3,540.7	3,548.5	3,840.1	2,757.4	4,226.3	5,712.4
CVP base and project deliveries	1,367.0	1,885.6	1,803.5	1,666.5	1,901.3	1,762.4	1,458.3	1,539.6
Other federal deliveries	64.3	102.5	65.8	97.6	4.4	2.5	2.6	2.2
SWP deliveries	4.3	4.8	4.6	3.5	8.6	16.7	14.2	5.4
Groundwater pumping	1,765.6	2,867.2	2,646.3	2,968.6	2,928.6	2,688.3	3,072.6	2,351.2
Reuse/recycle								
Reuse surface water	5,190.0	2,738.8	4,192.3	2,515.6	2,004.8	3,175.5	1,949.2	2,454.1
Recycled water	1.9	33.9	1.9	1.9	0.0	0.0	0.0	0.0
Inflow drainage from other hydrologic region	0.0	0.0	0.0	0.0	5.9	0.0	0.0	0.0
Total supplies	11,623	11,634	12,255	10,802	10,694	10,403	10,723	12,065

Source: DWR 2009a

Surface Water Use

Several irrigation districts in the San Joaquin River watershed use a mix of water supplies for agricultural and urban uses. Descriptions of the major irrigation districts in the watershed follow:

- South San Joaquin Irrigation District (ID) has source of surface water based on its senior water rights in the Stanislaus River and its 1988 Agreement and Stipulation with Reclamation for up to 300,000 acre-feet of Stanislaus River water annually. This surface water supply has been used historically to meet agricultural water demands (Reclamation 1999, p. 3-4).
- Oakdale ID has a supply of surface water based on its senior water rights in the Stanislaus River and its 1988 Agreement and Stipulation with Reclamation for up to 300,000 acre-feet of Stanislaus River water annually. Oakdale ID's service area is approximately 73,000 acres, and the City of Oakdale is the principal community (Reclamation 1999, p.3-4).
- Modesto ID encompasses a 108,000-acre service area and supplies surface water, groundwater, and electrical service to agricultural (64,000 irrigated acres) and municipal users including the cities of Waterford, Empire, Modesto, and Salida. Modesto ID has pre-1914 and post-1914 water rights (Reclamation 1999, p. 3-5).
- Turlock ID has a supply of developed surface water and operates surface diversions from the Tuolumne River. The district jointly operates the New Don Pedro Reservoir with Modesto ID. Surface water accounts for about 81 percent of the total delivery for irrigation (Reclamation 1999, p. 3-5).
- Merced ID has a supply of developed surface water and operates surface diversions from the Merced River. Merced ID uses surface and groundwater to supply approximately 552,000 acre-feet per year to irrigation customers. Surface water accounts for about 95 percent of the total delivery (Reclamation 1999, p. 3-5).
- Madera ID's service area covers 128,000 acres and includes the City of Madera (Madera ID 2011).

The SWP and the CVP convey Delta water into the San Joaquin Valley along the west side of the valley through San Joaquin, Stanislaus, Merced, and Fresno counties to water agencies in the valley. The federal Jones Pumping Plant near Tracy pumps into the Delta-Mendota Canal, which travels to San Luis Reservoir then toward the trough of the valley to Mendota Pool. CVP water brought in from the Delta is delivered to CVP contractors and San Joaquin River Exchange Contractors (Exchange Contractors).

The Exchange Contractors hold water rights dating back to the 1880s. Because of this early water usage, the water rights of the Exchange Contractors are based on their riparian and pre-1914 diversions. The Exchange Contractors have an agreement with Reclamation in which they agree not to exercise their San Joaquin River water rights in exchange for guaranteed deliveries of substitute CVP water from the Delta-Mendota Canal (Reclamation 1999, p. 3-2). The Exchange Contractors include four separate entities located in the San Joaquin Valley (three on the west side of the San Joaquin River and one on the east): the Central California Irrigation District, San Luis Canal Company, Firebaugh Canal Water Department, and Columbia Canal Company. The service area of 240,000 acres covers parts of Fresno, Madera, Merced, and Stanislaus counties.

CVP divisions in the San Joaquin River Watershed include the West San Joaquin, Eastside, and the Friant divisions. The following describes the facilities and operations of each of these divisions (Reclamation 1999, p. 13–15).

The West San Joaquin Division consists of the San Luis Unit and includes federal and joint federal and State of California water storage and conveyance facilities to provide for delivery of surplus water to CVP contractors in the San Joaquin Valley and in the San Felipe Division. Facilities in the West San Joaquin Division are San Luis Dam and Reservoir, O'Neill Dam and Forebay, the San Luis Canal, Coalinga Canal, Los Banos and Little Panoche Detention dams and reservoirs, and the San Luis Drain. San Luis Dam and Reservoir are located on San Luis Creek near Los Banos. The reservoir, with a capacity of 2 MAF, is a pumped-storage reservoir primarily used to store water exported from the Delta via Jones and Banks Pumping plants. It is a joint federal and State of California facility that stores CVP and SWP water from the Delta. San Luis Reservoir waters are released for delivery to the Delta-Mendota Canal to serve CVP water service and San Joaquin River Exchange Contractors on the west side of the San Joaquin Valley (Reclamation 1999, p. 13–15).

The Eastside Division includes water storage facilities on the Stanislaus River (New Melones Dam, Reservoir, and Powerplant), Chowchilla River (Buchanan Dam and Eastman Lake), and Fresno River (Hidden Dam and Hensley Lake) described under the previous surface water hydrology section. All of the dams and reservoirs in this division were constructed by the USACE. Eastman Lake and Hensley Lake are also operated by the USACE. Upon completion in 1978, New Melones Dam operation was assigned to Reclamation to provide flood control, satisfy water rights obligations, provide in-stream flows, maintain water quality conditions in the Stanislaus River and in the San Joaquin River at Vernalis, and provide deliveries to CVP contractors.

The operating criteria for New Melones Reservoir are governed by water rights, in-stream fish and wildlife flow requirements, in-stream and Delta water quality requirements, CVP contracts, and flood control considerations. Flows in the lower Stanislaus River serve multiple purposes. These include providing water for in-stream water rights obligations, meeting in-stream fishery flow requirements, maintaining in-stream water conditions of DO, and maintaining water quality conditions in the San Joaquin River at Vernalis, in accordance with SWRCB D-1422 and SWRCB's 2006 WQCP (Reclamation 1999, p. 13–15).

The Friant Division includes facilities to collect and convey water from the San Joaquin River in order to provide a supplemental water supply to areas along the east side of the southern San Joaquin River Basin and the Tulare Basin. The delivery of CVP water to this area augments groundwater and local surface water supplies in an area that has historically been subject to groundwater overdraft. The Friant Division is an integral part of the CVP, but is hydrologically independent and, therefore, operated separately from the other divisions of the CVP. The water supply to the Friant Division was made available through an agreement with San Joaquin River water right holders (Exchange Contractors), who entered into an exchange contract and purchase agreement with Reclamation for delivery of water through the Delta-Mendota Canal. Major facilities of the Friant Division include Friant Dam and Millerton Lake, the Madera Canal, and the Friant-Kern Canal. Flood control releases from Millerton Lake (Friant Dam) may be used to satisfy portions of deliveries to the San Joaquin River Exchange Contractors. Millerton Lake operations are coordinated with operations of the Delta-Mendota Canal in the Delta Division to use all available Millerton Lake flood control releases before additional water is delivered to Mendota Pool. During wet hydrologic periods, overflow from the Kings River may also enter the San Joaquin River Basin at the Mendota Pool through the Fresno Slough (Reclamation 1999, p. 13-15). In addition, during periods of high water, Kings River water may be diverted from the Tulare Lake basin into the San Joaquin River via Fresno Slough and the James Bypass (DWR 2009a, p. SJ-27).

Environmental Water Use

Several environmental water requirement programs allocate water for natural habitat in the San Joaquin River watershed.

The Vernalis Adaptive Management Program (VAMP), adopted as part of D-1641, is a large-scale, long-term (12-year), experimental management program initiated in 2000 that is designed to protect juvenile Chinook salmon migrating from the San Joaquin River through the Delta. VAMP is also a scientifically recognized experiment to determine how salmon survival rates change in response to alterations in San Joaquin River flows and SWP-CVP exports with the installation of the Head of Old River Barrier (DWR 2009a, p. SJ-12). VAMP expires by 2012. However, SWP and CVP are intending to voluntarily operate to VAMP-like provisions.

The federal CVPIA, passed by Congress in 1992, requires the Secretary of the Interior to implement a wide variety of CVP operation modifications and structural repairs in the Central Valley for the benefit of the wildlife and anadromous fish resources, including the goal of a sustainable level of specific species, races, and runs of anadromous fish populations at least twice the average population levels that were observed between 1967 and 1991. CVPIA provisions address operational improvements, such as implementation of fish passage and handling facilities, and operational changes in CVP facilities to provide water to support fisheries restoration and waterfowl at State and federal Central Valley wildlife refuges (DWR 2009a, p. SJ-12).

The San Joaquin River Restoration Program is a comprehensive long-term effort to restore flows to the San Joaquin River from Friant Dam to the confluence of Merced River, ensure irrigation supplies to Friant Water Users, and restore a self-sustaining fishery in the river. The San Joaquin River Restoration Program is a direct result of a September 2006 settlement on an 18-year lawsuit to provide sufficient fish habitat in the San Joaquin River below Friant Dam (near Fresno) by the U.S. Departments of the Interior and Commerce, the Natural Resources Defense Council, and the Friant Water Users Authority. Federal legislation was reintroduced on January 4, 2007, to authorize federal agencies to implement the settlement. Interim flows began October 1, 2009, and full restoration flows will begin no later than January 2014 (DWR 2009a, p. SJ-12).

Groundwater Use

Groundwater is the major source of water supply for agricultural areas in eastern San Joaquin County (NSJCGBA 2007, p. 4.14, Fig. 4-6). The City of Stockton primarily uses groundwater for its municipal and industrial water needs. Other cities such as Lathrop, Manteca, and Tracy use a mix of groundwater and surface water, while Lodi, Escalon, and Ripon primarily use groundwater for their municipal needs. Due to overdraft of the aquifer beneath Stockton, the city has limited groundwater extraction to 40,000 acre-feet per year.

The San Joaquin River area is heavily dependent on groundwater, which is used conjunctively with surface water when those supplies are not sufficient to meet the area's demand for agricultural, industrial, and municipal uses (DWR 2003, p. 169). As discussed in the groundwater hydrology section, overdraft is a major concern in some areas. Currently, urban and agricultural users on the valley floor are reliant on groundwater for water supply. In fact, groundwater supplies over 75 percent of water for users on the valley floor (Madera County 2008). Most San Joaquin Valley cities rely on groundwater either wholly or partially to meet municipal needs. For example, the Merced area is almost entirely dependent on groundwater for its supply (DWR 2003, p. 169). Groundwater is pumped by individuals, communities, and water districts. In addition, agricultural users pump groundwater when imported and local surface water supplies are not available.

Groundwater use in the San Joaquin River area is estimated to be between 730,000 and 800,000 acre-feet per year, which exceeds the basin's estimated safe yield of 618,000 acre-feet per year (DWR 2009a).

Water Recycling and Water Conservation

Recently, urban areas in the San Joaquin Valley have been investigating some water recycling and water conservation measures. For example, water metering did not occur until recently in the City of Fresno.

With metering and other measures in place, the City of Fresno has a goal to increase water savings via water conservation by 20 percent.

Water Exports and Transfers

EBMUD and SFPUC convey water from the San Joaquin River watershed east of the Delta for use in the San Francisco Bay Area via aqueducts (pipelines). EBMUD transports water from the Mokelumne River via the Mokelumne Aqueduct. This water goes to Alameda and Contra Costa counties in the East Bay. The Mokelumne River supplies more than 90 percent of the water supply to EBMUD, serving almost 1.3 million people. SFPUC and other nearby cities receive water through the Hetch Hetchy Aqueduct from the Tuolumne River in Yosemite. Nearly 4 million Bay Area people receive water from the San Joaquin River watershed (DWR 2009a, p. SJ-27).

The upper San Joaquin River runoff is diverted at Lake Millerton for use by federal water contractors within the Tulare Lake watershed via the Friant-Kern Canal. During periods of high runoff, San Joaquin River water can be transported to the Tulare Lake watershed in the Friant-Kern Canal to the Kern River (DWR 2009a, p. SJ-27).

Conjunctive Use and Groundwater Banking

Conjunctive use refers to the use and management of the groundwater resource in coordination with surface water supplies by users overlying the basin. The Northeastern San Joaquin County Groundwater Banking Authority (NSJCGBA) is a joint-powers authority whose mission is to develop local projects to strengthen water supply reliability in Eastern San Joaquin County. The NSJCGBA facilitated the development and adoption of the Eastern San Joaquin Groundwater Basin Groundwater Management Plan and completed its IRWMP. This plan outlines the requirements for an integrated conjunctive use program that takes into account the various surface water and groundwater facilities in eastern San Joaquin County and promotes better groundwater management to meet future basin demands (NSJCGBA 2004, p. 16–17). Potential projects include urban and agricultural water use efficiency projects, recycled municipal water projects, groundwater banking sites, new surface storage opportunities, improved conveyances, and new surface water sources (NSJCGBA 2007, pp. 7.13–7.53). Pursuant to the IRWMP, a program-level EIR was released in February 2011 that identifies the environmental consequences associated with the implementation of the integrated conjunctive use program, as well as identifies specific mitigation measures to reduce significant impacts (NSJCGBA 2011, p. 1-3).

The Farmington Recharge project, managed by the USACE, aims to recharge flood-season and excess irrigation water supplies in the Eastern San Joaquin groundwater subbasin. The USACE is currently conducting a feasibility study focused on groundwater recharge opportunities in the Farmington area (USACE 2011a).

A joint conjunctive use and groundwater banking project is being evaluated by the East San Joaquin Parties Water Authority and EBMUD, named the Mokelumne Aquifer Recharge and Storage Project (NSJCGBA 2004, p. 34). The goal is to store surface water underground in wet years, and in dry years, EBMUD would be allowed to extract and export the recovered water supply (NSJCGBA 2004, p. 34). Several studies have concluded that the test area is suitable for recharge and recovery of groundwater. However, more testing needs to be done to further evaluate the feasibility of this project.

3.3.5 Areas Outside the Delta that Use Delta Water

Discussion of areas outside the delta that use Delta water is divided into four major areas: the Tulare Lake watershed, the San Francisco Bay Area, the Central Coast, and Southern California.

3.3.5.1 Tulare Lake

The Tulare Lake watershed consists of approximately 10.9 million acres located at the southern end of the San Joaquin Valley and includes Kings and Tulare counties along with portions of Fresno and Kern counties (DWR 2009a, p. TL-5). It is an area bounded by the Sierra Nevada to the east, the Tehachapi Mountains to the south, and the Coast Ranges to the east (DWR 2009a, p. TL-5).

Separated from the northern portion of the San Joaquin Valley by a topographic rise between the San Joaquin River and Kings River watersheds, the Tulare Lake is a closed basin. Surface water spills into the San Joaquin River from the Tulare Lake watershed only in extreme flow conditions (DWR 2009a, p. T-9). Due to significant dependency on water in a region where the resource is typically scarce, management of surface water and groundwater through programs, projects, and infrastructure remains a high priority and is vital for the region's continuing success (DWR 2009a, p. TL-19).

Mean annual precipitation is 15.2 inches over the entire watershed. (DWR 2009a, p. TL-6), but is only 6 to 11 inches for the valley floor (DWR 2009a, p. TL-6, TL-13). The valley floor receives precipitation only in the form of rainfall, while the mountains experience moderate to heavy snowfalls, which provide an extended spring runoff period (DWR 2009a, p. TL-9).

3.3.5.1.1 Surface Water Hydrology

Before extensive development, the Tulare Lake watershed's four major river systems (the Kings, Kaweah, Tule, and Kern rivers) drained into the three lakes on the valley floor or into adjacent wetlands and marshes (DWR 2009a, p. TL-5).

The Kings, Kaweah, and Tule rivers historically drained to the Tulare Lake Bed, an area covering 200,000 acres on the valley floor in Kern and Kings counties, and the Kern River formerly flowed into the Kern, Buena Vista, and Goose lake beds (Reclamation 1997). Development of water supply and flood control projects on these rivers has virtually eliminated flow to the lakebeds, which now remain dry except during high-flow periods in wet years (Reclamation 1997).

The Kings River, originating in Kings Canyon National Park and flowing southwest to Pine Flat Reservoir, is the largest of the four main Sierra Nevada rivers (DWR 2009a, p. TL-7). The North, Middle, and South forks converge above Pine Flat Reservoir (Reclamation 1997, p. II-56). Upon release from Pine Flat, water in the Kings River flows to a bifurcation at Crescent Weir; the South Fork flows to the Tulare lakebed, and the North Fork flows to Fresno Slough (Reclamation 1997, p. II-56). In periods when flood releases from Pine Flat result in excessive flows, most of the Kings River flow is diverted through the James Bypass/Fresno Slough system to the San Joaquin basin (DWR 2009a, p. TL-7). It is only under these conditions that the Tulare Lake watershed exhibits a surface water outflow.

The Tule River originates in Sequoia National Forest and flows through Lake Success to the Tulare Lake Bed (DWR 2009a, TL-7). The Kaweah River originates in Sequoia National Forest and flows through Kaweah Lake to the Tulare Lake Bed (DWR 2009a, TL-7). Flowing out of the Inyo and Sequoia National Forests and Sequoia National Park, the Kern River drains the largest subbasin in the Tulare Lake watershed and flows into Lake Isabella (DWR 2009a, TL-7). From Isabella, the river flows southwest toward the Kern Lake bed and ultimately into the Buena Vista and Tulare Lake beds, and may also be diverted to the California Aqueduct through the Kern River Intertie (DWR 2009a, TL-7).

3.3.5.1.2 Surface Water Quality

The Tulare Basin receives high-quality mountain runoff water from the Kern, Kings, Kaweah, and Tule rivers along with imported water via water supply canals (Central Valley RWQCB 2004). The closed basin drains to Buena Vista and Tulare Lakes (normally dry), but water does not naturally flow out of the basin except during extreme flood flows. Normally, all inflows are used for agriculture, groundwater infiltration, or evapotranspiration. The lack of flushing contributes to salt buildup, which is the prime water quality problem of the basin (Central Valley RWQCB 2004). Salt management in the basin is under study as part of the CV-SALTS program (Central Valley RWQCB 2007a, Larry Walker Associates 2010). Drainage water management to control salts and selected chemicals such as selenium is being addressed as source control, drainage reuse, groundwater management, integrated on-farm drainage management, and the monitoring of agricultural drainage water (DWR 2010b, p. 2).

Average water quality concentrations of a variety of constituents for several Tulare Basin locations are provided in Appendix E. Little information was available for surface water quality, but the values in the table indicate fairly low conductivity and low nutrient concentrations.

Limited surface water quality monitoring results are available from the Kings, Kern, and Tule rivers and Lakes Isabella, Success, and Kaweah. Almost all records met Basin Plan standards except for typical lake effects due to low DO or elevated pH from algal growth in the reservoirs or slow moving sections of rivers. The exception was the lower Kings River, where elevated EC and ammonia were found in a few cases (Central Valley RWQCB 2007b, pp. 2-4). In the Tulare Lake Basin, selenium is of particular concern because of its effects on birds that feed and nest at agricultural drainage evaporation basins, where severe reproductive effects have been documented in several species (Skorupa 1998, p. 327). The mitigation wetlands are not allowed to average more than 2.7 µg/L total recoverable selenium in impounded water. The acreage of mitigation habitat required is determined using protocols developed by USFWS (2011).

3.3.5.1.3 Groundwater Hydrology

The Tulare Lake area overlies seven groundwater subbasins as defined by DWR: the Westside, the Kings, the Tulare Lake, the Kaweah, the Tule, the Pleasant Valley, and the Kern subbasins (DWR 2003, p. 169). The aquifer system consists of younger and older alluvium, flood-basin deposits, lacustrine and marsh deposits and unconsolidated continental deposits. These deposits form an unconfined to semi-confined upper aquifer and a confined lower aquifer in most parts of the Basin. These aquifers are separated by the Corcoran Clay (E-Clay) member of the Tulare Formation, which occurs at depths between 200 and 850 feet along the central and western portion of the basin. Groundwater generally flows from the Sierra Nevada on the east and the Coast Ranges on the west toward the San Joaquin River (DWR 2003) (see Figure 3-6).

Table 3-5 shows approximate annual estimates of groundwater budgets made by DWR for the Tulare Lake subbasins.

As described previously, all but the Westside subbasin are in critical overdraft (DWR 2003). The condition is each subbasin is elaborated below.

Groundwater levels in the Westside subbasin have fluctuated during the past 60 years in response to the availability of surface water deliveries from the CVP. The lowest estimated average groundwater level was 156 feet below sea level and occurred in 1967 (Westlands 2009, p. 9, Table 1). In 2008, groundwater levels were estimated at about 11 feet below sea level.

In the Kings subbasin, two notable groundwater depressions exist. One is centered on the Fresno-Clovis urban area. The other is centered approximately 20 miles southwest of Fresno in the Raisin City Water District (DWR 2006f). Between 1958 and 2006, groundwater levels have declined more than 60 feet in the City of Fresno area and approximately 140 feet in the southwest area of the subbasin (see Figure E-9, Appendix E). In general, the Kings subbasin is in overdraft condition (KRCD 2008, p. 6).

1 Figure 3-6
2 Groundwater Basins in the Tulare Lake Watershed
3 *Source: DWR 2003*

4
5

Table 3-5
Annual Groundwater Budget Components in the Tulare Lake Area

Groundwater Budget Components	Average Acre-feet per Year						
	Westside Subbasin	Kings Subbasin	Tulare Lake Subbasin	Kaweah Subbasin	Tule Subbasin	Pleasant Valley Subbasin	Kern County
Recharge from precipitation and surface water	Stream seepage: 35,000	ND	89,200	47,000	34,400	—	150,000
Recharge from applied water	193,000	ND	195,000	243,000	201,000	4,000	843,000 (in addition: artificial recharge of 308,000)
Subsurface inflow	into the upper aquifer: 25,000; into the lower aquifer: 175,000	–	–	–	–	–	233,000
Groundwater pumping	460,000*	—	672,000	546,000	672,000	104,530	1,400,300
Evapotranspiration	–	–	–	–	–	–	—
Subsurface outflow	–	–	–	–	–	–	Minimal

Source: Westlands 2009, DWR 2006f, 2006g, 2004g, 2004h, 2006h, 2006i
* Value estimated for 2008 (Westlands 2009)
—: not determined

In the Tulare Lake subbasin, water levels have declined nearly 17 feet on average from 1970 through 2000. Fluctuations in water levels have been most exaggerated in the lakebed area of the subbasin, which has experienced both the steepest declines and the steepest rises over time (DWR 2006g, p. 2). Between 1958 and 2006, groundwater levels in the northwest corner of the subbasin have declined by up to 60 feet (see Figure E-10, Appendix E).

In the Kaweah subbasin, water levels have declined about 12 feet on average from 1970 through 2000 (DWR 2004g, p.2). Between 1958 and 2006, groundwater levels have declined between 20 and 40 feet throughout the subbasin (see Figure E-11, Appendix E).

In the Tule subbasin, water levels have increased by about 4 feet on average from 1970 through 2000 (DWR 2004h, p. 2). However, between 1958 and 2006, groundwater levels have declined about 20 to 30 feet throughout the subbasin (see Figure E-12, Appendix E).

In the Pleasant Valley subbasin, groundwater levels are generally continuing a historical trend of decline. DWR measurements have indicated a decline of 5 to 25 feet during the past decade (DWR 2006h, p. 2). Between 1962 and 2006, this subbasin has seen a water decline of more than 100 feet (see Figure E-13, Appendix E).

Groundwater levels in the Kern County subbasin were quite variable in different portions of the basin between 1970 and 2000 (DWR 2006i, p. 3). Between 1958 and 2006, water levels decreased by more than 100 feet in the Bakersfield region (see Figure E-14, Appendix E). However, since the late 1970s, groundwater banking operations have helped maintain the groundwater levels fairly static, despite the increase in groundwater extractions in the Bakersfield area. The average change in storage in the Kern County subbasin between 1970 and 1998 was evaluated to be a decrease of 325,000 acre-feet per year (DWR 2006i, p. 4).

Groundwater quality in the region is generally suitable for most urban and agricultural uses. There are some localized impairments including high TDS (salts), sodium chloride, sulfate, nitrate, organic compounds, and naturally occurring arsenic. Salinity is the most significant issue facing groundwater in the region due to the impacts of agricultural practices as well as naturally occurring salts in local soils. The Central Valley RWQCB is currently leading an effort to address salinity because it is listed as the "greatest long-term problem facing the entire Tulare Lake Basin is the increase of salinity in ground water" (KCWA 2011). An estimated 1,206 tons of salt accumulates annually in the region from imported sources (DWR 2009a). This accumulation is trapped and builds up in the underlying aquifers because the Tulare Lake is a closed system without any natural outlets. Agricultural practices also add salts to the system when irrigation water high in salts is applied to the land. This water evaporates and crop transpiration removes water from the soil resulting in salt accumulation in the root zone. This accumulation has to be flushed from the root zone so water eventually percolates into the groundwater. High salt concentrations (greater than the primary drinking water standard) are a particular problem in the western portion of the Tulare Lake region.

Nitrate is another water quality concern in the region. Nitrate issues originate from agricultural practices including irrigation and dairy wastes and from wastewater and septic systems in the region. Manufactured pesticides used in agriculture and naturally occurring arsenic have occasionally contaminated domestic groundwater supplies.

Groundwater quality in the Tulare Lake subbasins is poor in the upper unsaturated zone, due to agricultural drainage issues and naturally occurring high salinity soils. The Westlands Water District area has especially suffered from groundwater affected by low-quality agricultural drainages. More than 200,000 acres of agricultural land overlay saline groundwater that occurs within 10 feet of the soil surface (Westlands 2011). The high clay content of the soils in that region restricts drainage in the upper aquifer. Studies have shown that the upper 20 to 200 feet of the saturated groundwater zone have been affected by the crop irrigation and drainage issues, and the useable average life of the Westside subbasin is estimated at 110 to 114 years (Reclamation 2006a, p. 6-2). The eastward movement of saline groundwater also affects the groundwater in neighboring regions, such as in City of Mendota and Fresno Slough (Reclamation 2006a, p. 6-2).

Reclamation performed an analysis of alternative actions that could help improve drainage issues in the San Luis Drainage Area by reevaluating the San Luis Drain capabilities. The findings were published in the final Environmental Impact Statement (EIS) in 2006. The retained preferred alternative was the "In-Valley/Drainage-Impaired Area Land Retirement Alternative" (Reclamation 2006a, p. ES-9), whereby a minimum of 44,106 acres of land is retired. Other options were being investigated, such as treating the drainage water and releasing it in Delta areas or conveying it to the ocean.

A recent study published by the Pacific Institute (2011) provides findings on nitrate content in groundwater drinking wells in Tulare County. Four communities were surveyed about their water systems, and all were in violation of the nitrate MCL for several years (Pacific Institute 2011, p. 20). This groundwater contamination has implications on health and the economy of the region.

Shallow groundwater occurs in the western and southern portions of the Kern County subbasin, which presents problems for agricultural operations (DWR 2006i, p. 4). An agricultural drainage study showed that shallow groundwater occurs between 0 and 20 feet below the ground surface in the southern portion of the Kern County subbasin (DWR 2010b, p. 122). The shallow groundwater is high in TDS and other salt analytes. TDS levels are highest in the shallow groundwater of the southern portion of the subbasin and can reach up to 7,900 mg/L. Selenium is found in concentrations ranging from 0.02 to 0.05 mg/L (DWR 2010b, p. 34). High salinity also occurs from the imported SWP and CVP surface water that is used for irrigation, a portion of which infiltrates into the shallow aquifer. It is estimated that 1,206 tons of salt are annually imported to the Kern County subbasin area (KCWA 2011, p.2-35). Elevated arsenic concentrations occur in certain areas that contain lakebed deposits.

Since the Tulare Lake has dried and is no longer able to recharge the Tulare Lake Basin, groundwater recharge from streams is highly variable and only occurs in wet years. In pre-development years, surface water and groundwater exchange occurred in both directions depending upon variations in hydrologic conditions. When groundwater levels declined due to rapid agricultural growth and heavy groundwater development, the primary interaction of surface water with groundwater became stream flow loss to underlying aquifers. In areas of severe overdraft, such as in Kings County, complete disconnection between groundwater and overlying surface water systems has occurred. Some of these losing streams are now also used as conveyance elements for irrigation purposes and to recharge groundwater. Complete disconnection between groundwater and overlying surface water systems has occurred in the Kern County area. Kern River, a losing stream, is used as a conveyance element for irrigation purposes and to recharge groundwater.

3.3.5.1.4 Water Use and Infrastructure

Irrigated agriculture represents the dominant water use in the Tulare Lake region, accounting for 82 percent of regional water use between 1998 and 2005 and nearly one-third of statewide agricultural water use (DWR 2009a, p. TL-21). The remaining 18 percent of water use is split between environmental (13 percent) and urban uses (5 percent) (DWR 2009a, p. TL-21).

Urban growth has increased the percentage of water supplies allocated to urban uses from 3.4 percent in 1980 to 5.4 percent in 2005. Urban demand trends have been accompanied by a decline in agricultural area and irrigation volume, with a reported decrease of 200,000 acres in irrigated area from 1990-2005 (DWR 2009a, p. TL-14, TL-21). Declining quality of groundwater supplies for urban demands has also prompted several cities, including Fresno, Clovis, and Bakersfield, to augment their groundwater sources with treated surface water (DWR 2009a, TL-21).

Table 3-6 summarizes the water supply sources in the Tulare Lake region.

Table 3-6
Water Supplies in the Tulare Lake Region

Water Supply Source	Water Supply (Thousand Acre-Feet)							
	1998	1999	2000	2001	2002	2003	2004	2005
Surface water								
Local deliveries	3,622	2,257	2,397	1,698	1,658	1,922	1,676	2,995
CVP base and project deliveries	1,811	2,567	2,280	1,788	1,896	2,175	1,977	2,749
SWP deliveries	1,035	1,661	1,915	849	948	1,048	1,021	1,404
Groundwater pumping	2,708	5,114	4,937	6,985	7,144	6,120	7,187	3,504
Reuse/recycling	3,205	1,151	1,331	964	1,096	1,464	1,214	2,365
Total supplies	12,381	12,749	12,861	12,285	12,741	12,730	13,075	13,015

Source: DWR 2009a

The Tulare Lake area is reliant on local water supplies, groundwater and imported surface water. On average, between 1998 and 2005, 43 percent of the regional water supply consisted of groundwater. Imported water from State and federal projects accounted for 27 percent of the regional supply, while local deliveries accounted for 18 percent. Except in the case of extremely wet years, all local and imported surface water supplies not lost to consumptive use or evapotranspiration eventually percolate back into local groundwater aquifers (DWR 2009a, p. TL-21).

Surface Water Use

Unlike other hydrologic regions in the Central Valley, none of the local surface water supplies is owned or operated by the CVP or the SWP; therefore, CVP and SWP infrastructure is primarily focused on distributing imported water supplies within the Tulare Lake Basin.

Each of the river systems is regulated for irrigation and flood control with flows diverted for irrigation or other purposes except during the wettest years. The Kings and Tule rivers are listed by the SWRCB as fully appropriated streams, and the Kern was listed as fully appropriated until 2010. In 2010, the Kern River was removed from the list following a petition by several parties in the basin, which came as a result of a federal court ruling that found there was a partial forfeiture of Kern Delta Water District's pre-1914 water rights on the Kern River. The amount of unappropriated water on the Kern River system, however, remains relatively small compared to the total amount of appropriated water.

A number of agricultural and urban diverters use water from rivers in the region. There are 14 diversions located on the mainstem of the Kings River between Pine Flat Dam and Crescent Weir, one agricultural diversion on the North Fork/Fresno Slough, and eight diversions on the South Fork (Reclamation 1997). There are 12 agricultural diversions below Lake Kaweah on the river. There are a number of small diverters above Lake Success on the Tule River. Eight notable agricultural diversions between Lake Success and Tulare Lake on the Tule River also divert flow. These diverters averaged from 500 to 21,400 acre-feet per year from 1961 to 1977). There are 14 agricultural diversions from the Kern River. From 1961 to 1977, the total annual diversion from all 14 ranged from 175,000 to 2 MAF per year and averaged 427,000 acre-feet per year (Reclamation 1997).

Imported Water

The Tulare Lake watershed depends heavily on imported water from the SWP via the California Aqueduct and the CVP via the Friant-Kern Canal and Cross Valley Canal. The CVP delivers water along the eastern area of the valley via the Friant-Kern Canal and along the western area of the valley via the San Luis Canal. SWP delivers water via the California Aqueduct, which lies along the entire western side of the valley floor and serves the western portion of the valley from Kings County southward. Water districts along the western side of the valley floor, where groundwater quality is poor, rely extensively on imported water from the CVP and SWP.

Reflecting overall water use, State and federal contractors use their contract water primarily for agricultural production (96 percent of the total CVP contract amounts, and 89 percent of the total SWP contract amounts). Kern County Water Agency (KCWA), a water wholesaler supplying water to subcontractors, has the largest contract at over 1.8 MAF annually.

The Cross Valley Canal, operated by the Kern County Water Agency, conveys water from the California Aqueduct on the west side of the basin to users on the east side of the basin, near Bakersfield and the terminus of the Friant-Kern Canal. Recent expansion of the canal has heightened connectivity between the Kern River, the Friant-Kern Canal, and the California Aqueduct and enabled bi-directional flows and higher flow rates through the canal. The Cross Valley Canal conveys SWP and CVP surface water and connects surface supplies with the Kern Water Bank (DWR 2009a, p. TL-19).

The availability of imported surface water depends on the amount of runoff, which varies from year to year, and on regulations that determine the amount of water that can be pumped in accordance with environmental concerns. Water quality and environmental needs in the Delta are reducing the amount of water exported from the Delta and available for use in the Tulare Basin.

Environmental Water Use

Though all of the major rivers in the Tulare Lake watershed are regulated, portions of the Kings and Kern Rivers have been designated as Wild and Scenic Rivers, and a segment of the Kaweah River is currently under consideration for the designation (DWR 2009a, p. TL-18). Flow levels are determined based on unimpaired flow estimates. The Kings River segments extend upstream from the Tulare-Kern county line. The portion of the North Fork of the Kern River is upstream of the Domelands Wilderness in Sequoia National Forest, while the segment of the South Fork of the Kern River extends upstream from 1,595 feet above mean sea level. In addition, the Kern National Wildlife Refuge receives CVP deliveries specified under the CVPIA.

Groundwater Use

The Tulare Lake area is heavily groundwater dependent. Groundwater is used conjunctively with surface water when those supplies are not sufficient to meet the region’s demand for agricultural, industrial, and municipal uses (DWR 2003, p. 169). Overdraft is a major concern in some areas. Currently, urban and agricultural users on the Valley floor are reliant on groundwater for water supply. The cities of Fresno and Visalia are almost entirely dependent on groundwater for their water supplies, with Fresno being the second largest city in the United States reliant almost solely on groundwater (DWR 2003, p. 177). However, these cities are starting to look for other water sources and some have started groundwater storage programs (as described below). Mountain and foothill communities are dependent on groundwater from fractured rock wells, whose productivity is impacted during short-term droughts. Groundwater is pumped by individuals as well as communities and water districts. In addition, agricultural users pump groundwater when imported and local surface water supplies are not available.

Groundwater use is estimated to account for approximately 41 percent of the total water supply to the Kern County subbasin region (KCWA 2011, p. 2-27). Agriculture is the largest user of groundwater in the subbasin. Groundwater extractions include urban extraction of 154,000 acre-feet per year, agricultural extraction of 1,160,000 acre-feet per year, and other extractions (oil industry related) of 86,333 acre-feet per year. The City of Bakersfield currently obtains all its delivered water supply through groundwater pumping, which amounts to about 38,700 acre-feet (City of Bakersfield 2007, pp. 3.1–3.2). The city water system manages the groundwater basin levels through ongoing recharge projects and has been able to maintain a positive water balance (City of Bakersfield 2007, p. 3.2).

Local and imported surface water supplies are both marked by a high degree of variability, making the region more highly dependent upon groundwater in dry periods (DWR 2009a, p. TL-19). However, the basin generally underlying the Tulare Lake experiences a net loss to storage indicating that in the last several decades, water demands have surpassed sustainable supply levels in the basin.

Water Recycling and Water Conservation

Since the Tulare Lake Basin is a closed system with no natural outflow, almost all the water used in the basin needs to be treated and disposed of within the basin (KCWA 2011, p. 2-30). Much of the treated wastewater is reused for nonfood crop irrigation as well as for groundwater recharge.

The City of Bakersfield has reused wastewater since 1912 to irrigate crops. The city continues this practice today by using recycled water for agricultural and urban irrigation and for groundwater recharge. The city is one of the largest producers of recycled water in the state.

Recycled water use in the Fresno-Clovis area consists of secondary treatment of 80 mgd of wastewater and disposal in evaporation ponds. Water in the evaporation ponds results in incidental recharge of the groundwater basin. Farmers in the region also use approximately 6,000 to 10,000 acre-feet per year of water from the ponds for irrigation. Total recycled water produced by this effort is approximately 65,300 acre-feet per year. In addition, the North Fresno Recycled Water Project is projected to supply between 750 and 1,250 acre-feet per year for golf course irrigation. In most of the communities, water is recycled for use by irrigators. Agricultural tailwater return systems are also used to recover and reuse water. These return systems collect runoff and transport it to the main irrigation system. Recycled water also is used to supply water to the Kern National Wildlife Refuge. Water conservation efforts in the region had primarily been through public information and incentive programs (City of Fresno 2011a).

Water Exports and Transfers

The California Aqueduct conveys exported Delta water through the Tulare Lake Basin to meet demands in Southern California. Additionally, water from the Kern Water Bank or Kern River water in high-flow conditions may be diverted through the Cross Valley Canal and the Kern River Intertie to the California Aqueduct for export to Southern California (DWR 2009a, p. TL-19).

Conjunctive Use and Groundwater Banking

Conjunctive use is an important component of the water management system in the Kern County subbasin. Groundwater banking is the storage of excess water supplies into aquifers during wet periods for later withdrawal and use during dry periods (KCWA 2011, p.2-29). The stored water is used through conjunctive use programs by users directly overlying the basin, or it is conveyed to users in regions outside of the groundwater basin. Water for storage may be imported from other regions or agencies for temporary or long-term storage and subsequent export out of the basin.

As described below, many groundwater banking facilities supplement water supplies delivered to customers in dry years, when insufficient surface water supplies are available to meet all the requirements. The KCWA manages a conjunctive use program in the metropolitan Bakersfield area, known as Improvement District No. 4 (ID4) (AGWA 2000, p. m-1). This program helps the region supplement its groundwater resources by storing surface water delivered by the SWP (approximately 60 to 70 percent of its total entitlement) by direct recharge into local aquifers (AGWA 2000, p. m-1), which can be used later through pumping of production wells. Various conjunctive use programs have been operated in the region since the early 1900s (KCWA 2011, p.2-29; AGWA 2000, p. m-1). For example, the City of Bakersfield owns and operates the “2800 Acres” recharge facility, which allows surface water from the Kern River, SWP, and federal sources to percolate into the subsurface for later use. An average of 18,200 acre-feet of water is banked annually in the recharge facilities (City of Bakersfield 2007, p. 3.7). The program has a balance of available groundwater estimated at approximately 200,000 acre-feet (City of Bakersfield 2007, p. 3.2). The City of Bakersfield plans to use treated Kern River water supplies to replace approximately 6,500 acre-feet of groundwater with treated surface water (City of Bakersfield 2007, p. 3-10).

Most groundwater subbasins in the Tulare Lake watershed are in a state of overdraft as a consequence of groundwater pumping that exceeds the basin’s safe yield (the amount of water needed to replenish the basin). As a result, the aquifers in these groundwater basins contain a significant amount of potential storage space that can be filled with additional recharged water. Several water agencies are coordinating efforts in the Kings River subbasin to mitigate for the extensive historical groundwater withdrawals. For example, the McMullin Recharge Group was “formed to address the long-term water supply imbalance in the Raisin City area caused by the lack of surface water available for irrigation” (KRCD 2011). The Kings River Conservation District (KRCD) also leads efforts in three groundwater management areas southwest of Fresno. Groundwater banking programs require additional water level monitoring, and KRCD has released annual groundwater reports for its service area that describe changes in groundwater levels and compute changes in groundwater storage with a numerical groundwater model (KRCD 2008).

The City of Fresno, which used to rely entirely on groundwater for its municipal water needs, has implemented a groundwater recharge program through the City-owned Leaky Acres facility. This facility comprises 26 ponds covering approximately 200 acres (City of Fresno 2011b). The surface water used to fill these ponds is provided through a contract with the Reclamation (60,000 acre-feet per year) and via the Fresno Irrigation District canals. Additional smaller recharge sites also exist in the region.

Historical water supply fluctuations and a general trend in declining groundwater levels in the Kern County subbasin have prompted local agencies to develop groundwater banking programs to store water underground during wet years, and retrieve it during dry years. The two major groundwater banking programs in Kern County are the Kern Water Bank operated by the Kern Water Bank Authority and the Semitropic Groundwater Bank, operated by the Semitropic Water Storage District (Semitropic WSD).

The Kern Water Bank Authority (KWBA) is located west of Bakersfield and covers nearly 30 square miles of the Kern County subbasin. The Kern Water Bank comprises 7,000 acres of recharge ponds that are filled with surplus SWP water that is allowed to infiltrate into the subsurface (KWBA 2011). Eighty-five recovery wells are used to pump groundwater out of the aquifer in dry years when additional water is needed for irrigation. The KWBA operates the largest water banking program in the world and has contributed over 3 MAF of water into storage since the program began operations in 1995 (KCWA 2011, p. 2-29).

The Semitropic WSD is located west of Wasco and covers more than 220,000 acres. The Semitropic Groundwater Bank currently stores 700,000 acre-feet of water, and has a total storage capacity of 1.65 MAF (Semitropic 2011a). The Semitropic WSD Stored Water Recovery Unit partnered with the Antelope Valley Water Bank, located close to Rosamond in the Kern County portion of the Antelope Valley, to form the Semitropic-Rosamond Water Bank Authority (Semitropic-Rosamond WBA) (Semitropic 2011b). This joint authority has the capacity of storing a combined 800,000 acre-feet of water with a recharge capacity of 113,000 acre-feet per year, and a recovery capacity of 200,000 acre-feet per year (Semitropic 2011b).

The major banking partners of Semitropic WSD are listed in Table 3-7, including the amount of allocated storage capacity.

Table 3-7
Semitropic WSD Groundwater Banking Partners

Agency	Allocated Storage (acre-feet)
Metropolitan	350,000
Santa Clara Valley Water District	350,000
Alameda County Water District	150,000
Newhall Land and Farming Company	55,000
San Diego County Water Agency	30,000
Zone 7 Water Agency	65,000
Total	1,000,000

Source: Semitropic 2011c

Other banking programs include the following:

- City of Bakersfield 2800 Acres Recharge Facility
- Arvin-Edison Water Storage District Banking
- Kern Tulare and Rag Gulch Water Districts Banking
- Buena Vista Water Storage District Banking
- Rosedale-Rio Bravo Water Storage District Banking
- Kern Delta Water District Banking
- Cawelo Water District Banking

More than 30,000 acres of groundwater recharge ponds are estimated to exist in the Kern County subbasin area. The total groundwater banking capacity in the region is estimated at 1.5 MAF per year, with maximum annual recovery estimated at 900,000 acre-feet (KCWA 2011, p. 2-30). The long-term storage potential of the Kern County subbasin is estimated at 8 MAF (AGWA 2000, p. 2).

Infrastructure used for groundwater banking includes recharge basins, recharge canals, recovery wells, and conveyance pipelines. In addition, connections to regional conveyance infrastructure such as the Friant-Kern Canal, the Cross Valley Canal, and California Aqueduct are necessary to move surface water into and out of the recharge areas. Groundwater banking programs have developed various interties to the regional conveyance systems such as the Semitropic WSD Intake Canal and the Kern Water Bank Canal (KCWA 2011, p. 2-42).

3.3.5.2 San Francisco Bay Area

The San Francisco Bay Area (Bay Area) covers over 4,600 acres of the coastal plain bounded on the east by the crest of the Coast Ranges mountains. Development of water in the Bay Area was driven by limited local supplies of freshwater and by the demand to meet the population and economic growth that started during the gold rush of the 1850s. The Bay Area has three distinct regions of land use: (1) agricultural farmland in the north, (2) a dense urban area in San Francisco, and (3) a mix of urban and rural in the south. This area has the second-largest population in the state and represents 17 percent of the state’s population. The Bay Area covers 9 counties and has 100 cities within its boundaries (BAWAC 2006a, p. ES-4).

The Bay Area has a Mediterranean climate with moist, mild winters and dry, hot summers. Precipitation in the area varies widely from year to year (from 9 to 44 inches per year) with an average precipitation of 21 inches per year (DWR 2009a, SF-8). Precipitation occurs mostly from November to April. Area climate is impacted by the southern descent of the polar jet stream and other weather patterns that develop over the Pacific Ocean. Rainfall amounts vary in the North Bay (20 to 25 inches) and South Bay (15 to 20 inches), but are highest in the east-facing mountains (over 40 inches). Temperatures in the area also are variable with coastal areas being up to 10 degrees cooler than inland areas. Temperatures are variable, ranging from 30°F to 80°F on average (BAWAC 2006a, B-12).

3.3.5.2.1 Surface Water Hydrology

Major rivers and streams in the Bay Area include the Guadalupe River, Alameda Creek, and Coyote Creek draining the southern Coast Ranges and the Napa River and Sonoma River draining the northern Coast Ranges (DWR 2009a, SF-5).

The Sacramento and San Joaquin rivers flow through the Delta into the San Francisco Bay. Delta outflows vary with precipitation, reservoir releases, and diversions upstream. Delta outflows contribute an average of 18.4 MAF per year of freshwater to San Francisco Bay. However, daily tidal flux through the Carquinez Strait is much higher than the freshwater flows (DWR 2009a, p. SF-3).

3.3.5.2.2 Surface Water Quality

Variations in Delta water quality can cause spikes in constituents that affect water treatment plants result in plant shutdowns or the need to change or blend supply sources (BAWAC 2006b, p. 23). Bay Area agencies use a mix of solutions to address these issues, including advanced treatment methods to remove TDS and other constituents, operation of reservoirs/conveyance systems in the region to provide a blended water supply, and source water protection.

A number of TMDLs are proposed or are being established, including TMDLs for sediments, pathogens, nutrients, mercury, polychlorinated biphenyls, and urban pesticides. Watershed protection including water treatment, flood control and stream restoration, and land use management projects are being used to meet TMDL objectives.

3.3.5.2.3 Groundwater Hydrology

The Bay Area includes 28 groundwater basins, as defined by DWR (DWR 2003, p. 131). The most heavily used basins that receive imported water from the Delta include Santa Clara Valley, Napa Valley, and Livermore Valley groundwater basins.

The Santa Clara subbasin has historically experienced decreasing groundwater level trends. Between 1900 and 1960, water level declines of more than 200 feet from groundwater pumping have induced unrecoverable land subsidence of up to 13 feet (SCVWD 2011). Importation of surface water via the Hetch Hetchy and South Bay Aqueducts and the development of an artificial recharge program have favored the rise of groundwater levels since 1965 (DWR 2004i, p. 2). The Niles Cone subbasin was in overdraft condition through the early 1960s. In 1962, SWP water was delivered to Alameda County Water District (ACWD) and used to recharge the groundwater subbasin. Since the early 1970s, groundwater levels have risen due to artificial recharge.

Groundwater in the Napa-Sonoma Valley basin occurs in confined and unconfined aquifers. Well yields are generally between 10 to 100 gpm, but some areas can yield up to 3,000 gpm. Groundwater in the Napa Valley floor generally flows toward the axis of the valley and then south, except in areas where influenced by groundwater pumping, where local cones of depression exist. Groundwater levels in Napa County are generally stable except for the Milliken, Sarco, and Tulucay (MST) creeks area, where significant declines in groundwater levels have been observed, especially in the central portion of the area. Water levels have been gradually declining since at least the 1960s. The observed declines in water levels are likely the result of groundwater pumping activities in the basin (WICC 2005, p. 16-9). The MST creeks area represents the largest groundwater consumption area in Napa County. This area has been defined by the county as groundwater-deficient and therefore requires special consultation to determine the need for a groundwater permit. Recharge to the alluvial aquifers occurs primarily by direct infiltration of precipitation and to a lesser extent by infiltration of applied water from irrigation and infiltration through the stream and lakebeds.

The Livermore Valley groundwater basin contains groundwater-bearing materials originating from continental deposits from alluvial fans, outwash plains, and lakes. Well yields are mostly adequate and in some areas can produce large quantities of groundwater for all types of wells (DWR 2006j, p. 1). The movement of groundwater is locally impeded by structural features such as faults that act as barriers to groundwater flow, resulting in varying water levels in the basin. Groundwater follows a westerly flow pattern, similar to the surface water streams, along the structural central axis of the valley toward municipal pumping centers (Zone 7 2005, p. 3-7). Groundwater levels in the main portion of the Livermore Valley basin started declining in the 1900s, following historical artesian conditions, when groundwater pumping removed large quantities of groundwater. This trend continued through the 1960s. In 1962, Zone 7 began importing SWP water and later captured local runoff and stored it in Lake Del Valle. The import of additional surface water alleviated the pressure on the aquifer, and groundwater levels started to rise in the 1970s. However, historical lows were reached again during periods of drought.

Groundwater quality in the Bay Area is generally good and suitable for most agricultural and municipal uses, but concerns exist about contamination. In basins located near the ocean or where seawater intrusion has occurred, TDS and hardness are issues. Seawater intrusion is prevalent in groundwater basins near San Francisco Bay, northern Santa Clara Valley, and Napa Valley. High TDS and hardness are a problem caused by pipe scaling and appliance corrosion. Nitrates occur naturally or result from agricultural practices. In the Napa Valley subbasin, high concentrations of boron, TDS, and iron have been found. Boron in this basin is naturally occurring but is a concern because levels in parts of this basin exceed MCLs for drinking water. High Boron levels also occur in the Livermore Valley basin. Contaminated groundwater is another issue facing the Bay area. Contamination is from industrial and agricultural chemical spills, underground and above ground storage tank and sump failures, landfill leachate, septic tank failures, and chemical seepage. There are over 800 groundwater cleanup projects in the area with the majority caused by leaking fuel tanks (DWR 2009a). Also, several Department of Defense sites that need remediation are located in the Bay Area.

In the southern Bay Area, groundwater and surface water are connected through in-stream and off-stream artificial recharge projects, in which surface water is delivered to water bodies that permit the infiltration of water to recharge overdrafted aquifers. Natural groundwater recharge also occurs from stream seepage during the wet season. Surface water is mostly losing to groundwater, as the groundwater basins have been pumped extensively for various uses.

3.3.5.2.4 Water Users and Infrastructure

Water in the Bay Area is used to supply agricultural (21 percent), urban (21 percent), and environmental (58 percent) users. Agricultural use covers 943,000 acres of irrigated farmland. The majority of agriculture is in Solano and Sonoma counties, with some agriculture in northern Napa County and the southern portion of Contra Costa County. Urban uses occur in San Francisco, Silicon Valley, and Sonoma County. Environmental use occurs primarily in Santa Clara, Alameda, Contra Costa, Marin, and Sonoma counties.

The Bay Area is surrounded by saline water but has limited supplies of freshwater. Water supply has historically originated from local supplies, groundwater, and imported water supplies as seen in Table 3-8.

Table 3-8
Water Supplies in the San Francisco Bay Area

Water Supply Source	Water Supply (Thousand Acre-Feet)							
	1998	1999	2000	2001	2002	2003	2004	2005
Surface water								
Local deliveries	273.7	1,570.6	244.0	216.4	1,009.3	805.0	1,010.6	1,688.0
Local imported deliveries	489.4	506.1	502.9	529.8	532.1	524.8	509.3	504.7
CVP base and project deliveries	104.7	103.2	108.6	109.4	136.2	201.6	101.7	94.6
Other federal deliveries	37.7	36.3	34.5	37.5	47.7	51.0	42.2	44.1
SWP deliveries	146.0	101.1	155.0	121.3	207.1	175.4	176.5	172.0
Groundwater net withdrawal	-17.2	147.5	81.8	163.6	32.5	65.4	-119.3	-80.9
Deep percolation of surface and groundwater	54.8	73.5	57.5	56.3	217.4	198.9	378.4	331.8
Reuse/recycle								
Reuse surface water	0.0	0.7	0.0	0.0	23.2	22.5	32.7	29.5
Recycled water	22.4	27.5	22.4	22.4	10.9	11.5	0.0	0.9
Desalination	0.0	0.0	0.0	0.0	0.0	0.0	3.9	3.9
Total supplies	1,112	2,567	1,207	1,257	2,216	2,056	2,136	2,789

Source: DWR 2009a

In addition, water conservation, water recycling, and desalination are used to help meet water demands. Water supplies are from local water supply sources (44 percent), groundwater (11 percent), local imported water (27 percent), CVP imported water (6 percent), and SWP imported water (8 percent). The remainder of the supply is met by other federal project deliveries and recycled water (DWR 2009a, SF-9). This water is used to meet agricultural, environmental, and urban demands.

Additional water sources are being investigated in the Bay Area:

- Stormwater management: a source that can be captured either locally through changes in design (low-impact design) or using retention structures to impound water. This water can be stored in reservoirs or recharged into groundwater.
- Desalination: CCWD, EBMUD, Santa Clara Valley Water District (SCVWD), and SFPUC are jointly funding a study and pilot test to investigate seawater desalination. In the North Bay, the Marin Municipal Water District also has investigated desalination since the 1990s.

Surface Water Use

Surface water in the Bay Area includes runoff capture and stream diversions, local use of Delta water, and imported water. Local surface water constitutes over 40 percent of the water supplied in the Bay Area. It is used to supply users in the North Bay and South Bay areas through stream diversions and capture. In addition, water is captured in reservoirs (over 100,000 acre-feet of storage) and used to recharge groundwater basins for subsequent supplies by the SCVWD and the ACWD.

Delta water is used by CCWD through diversions to Los Vaqueros Reservoir, water diverted at Mallard Slough, and water diverted from the San Joaquin River. Also, Delta water is conveyed via the North Bay Aqueduct to the Solano County Water Agency. Over 30 reservoirs with a storage capacity of greater than 800,000 acre-feet capture and store water in the Bay Area.

In Alameda County, runoff from most of the southern region is collected in Calaveras and San Antonio reservoirs, which are part of San Francisco’s water system. Runoff from most of the southeast portion is collected in Del Valle Reservoir, some of which is diverted to ACWD via the South Bay Aqueduct. Runoff from the northern region flows to tributaries of Alameda Creek, where it is carried to ACWD facilities and used for groundwater recharge (ACWD 2011a).

Imported Water

For over a century, a majority of urban water supplied to the area has been from imported sources. One of the first projects to import water from a non-adjacent watershed was the City of San Francisco’s Hetch Hetchy project. SFPUC provides imported water from the Hetch Hetchy Reservoir on the Tuolumne River via the Hetch Hetchy Aqueduct to San Francisco, San Mateo, Alameda, and Santa Clara counties.

A similar project was developed by EBMUD, which was formed in 1923 to serve the eastern portions of the Bay Area near the City of Oakland. Water storage was developed on the Mokelumne River. The Pardee Dam and Mokelumne Aqueduct were completed in 1929. Counties served by this imported water originating in the Mokelumne River are Alameda and Contra Costa.

The Bay Area receives imported water from the SWP through the North Bay Aqueduct and the South Bay Aqueduct, and receives CVP water via the San Felipe Canal previously stored in the San Luis Reservoir. Imported water sources are given in Table 3-9.

Table 3-9
Imported Water from the Delta Watershed in the San Francisco Bay Area

Water Conveyance Facility Name	Water Source	Operator	Counties Served	Water Supplied in 2005 (Thousand Acre-Feet)
San Felipe Unit of CVP	Delta Water via San Luis Reservoir	Reclamation (CVP)	Santa Clara and San Benito counties	35.6
North Bay Aqueduct (SWP)	Northern Delta Water	DWR (SWP)	Solano and Napa counties	40.2
Putah South Canal (Solano Project)	Lake Berryessa	Reclamation	Solano County	44.1
Contra Costa Canal	Western Delta Water	CCWD (CVP)	Contra Costa County	59
South Bay Aqueduct (SWP)	Delta Water	DWR (SWP)	Alameda and Santa Clara counties	131.8
Mokelumne Aqueduct	Mokelumne River	EBMUD	Alameda and Contra Costa counties	200.6
Hetch Hetchy Aqueduct	Tuolumne River	SFPUC	San Francisco, San Mateo, Alameda, and Santa Clara counties	267.3

Source: DWR 2009a, p. SF-11.

The SWP conveys Delta water via the North Bay Aqueduct to the Solano County Water Agency. Water from the North Bay Aqueduct is supplied to the cities of Benicia and Vallejo, Napa County, and Travis Air Force Base. In addition, Suisun City, Rio Vista, and Dixon have rights to North Bay Aqueduct water but do not have conveyance facilities to receive water. North Bay Aqueduct water is also stored in Lake Herman, which can supply up to 500 to 1,000 acre-feet per year in wet years. North Bay Aqueduct water reliability is subject to SWP available supplies.

Water stored in Lake Berryessa is conveyed via the Solano Project to Solano County Water Agency. This water is supplied to Fairfield, Suisun City, Vacaville, Vallejo, Solano ID, Marine Prairie WD, UC Davis, and California State Prison- Solano (CALFED 2005, p. 3-30).

Water agencies in Contra Costa County receive water from the CVP via the Contra Costa Canal and from new water rights associated with Los Vaqueros Reservoir expansion. The Contra Costa Canal supplies water to the cities of Antioch and Pittsburg and to agriculture irrigators in the county. Delta water is used by CCWD through diversions to Los Vaqueros Reservoir, water diverted at Mallard Slough, and water diverted from the San Joaquin River (BAWAC 2006a, B-27).

Water agencies in Alameda County receive SWP water and water from the EBMUD Mokelumne Aqueduct and Pardee Dam. The South Bay Aqueduct conveys water from the Delta to Alameda and Santa Clara counties. Santa Clara Valley WD water supplies include SWP via the South Bay Aqueduct, CVP water via the San Felipe Division of the CVP, and water from SFPUC’s Hetch Hetchy Aqueduct. The Hetch Hetchy Aqueduct also supplies water to San Francisco and San Mateo County. Bay Area water contractors primarily import water for municipal and industrial purposes from both the SWP and CVP. Some water for agricultural uses is also imported from the CVP.

Environmental Water Use

In-stream flow requirements below most major dams and diversions in the Bay Area are mandated by the SWRCB licenses and the Federal Energy Regulatory Commission licenses, as well as agreements with other agencies. No streams in the Bay Area are designated as Wild and Scenic. Two endangered species, the Coho salmon and the steelhead trout, are endangered species found in Bay Area streams (DWR 2009a, p. SF-10).

Groundwater Use

Groundwater represents over 10 percent of total water supply in the Bay Area. In Santa Clara County, approximately 160,000 acre-feet of groundwater is pumped annually by local water suppliers and private well owners to meet municipal, domestic, agricultural, and industrial water needs (SCVWD 2011). Alameda County reports that about 31,400 acre-feet of water is pumped annually from the Niles Cone subbasin for a variety of uses (ACWD 2011b).

In Napa County, groundwater is primarily used for irrigation, then for rural domestic use, and a small portion is used for municipal purposes. For example, in the MST creeks area, it is estimated that 73 percent of total groundwater use is for irrigation purposes and 27 percent is for rural domestic use (WICC 2005, p. 16.7).

In Livermore Valley, an average of 25 percent of the potable water supply produced by Zone 7 comes from groundwater pumped from the basin that has been recharged artificially. In addition, other entities also pump groundwater for potable uses, increasing the average amount of groundwater pumped for potable use from the Livermore Valley basin to 35 percent. About 12,000 acre-feet per year of the groundwater extractions include evaporative losses to mining water from the gravel pits (about 3,000 acre-feet per year), municipal pumping by various retailers (about 7,200 acre-feet per year), private pumping, industrial supply and domestic supplies (about 1,200 acre-feet per year), and agricultural pumping for irrigation (about 500 acre-feet per year) (Zone 7 2005, p. 3-9).

Treatment of brackish groundwater is allowing previously unused groundwater to be used as a potable water source. Groundwater desalting is being used to reclaim and improve local brackish groundwater basins. In 2003, the first groundwater desalter went into production. The 5-mgd ACWD Newark Desalination Facility removes salts and other constituents from the Niles Cone subbasin groundwater for supply as potable water. This plant uses the reverse-osmosis process and discharges brine to a flood control channel. In addition, the Peralta Tyson Groundwater Treatment Facility is a future groundwater desalting project that reclaims water from the Niles Cone Groundwater Basin.

In 2009, the Zone 7 Water Agency began operation of the Mocho Groundwater Demineralization Plant. This plant produces 6.1 mgd of potable water for blend with other water supply sources. The Mocho Groundwater Demineralization Plant uses reverse osmosis to remove TDS and hardness from the Livermore-Amador Valley's groundwater basin and discharges brine to the Dublin San Ramon Sanitation District brine sewer line.

Water Recycling and Water Conservation

The Bay Area agencies have improved reliability by enhancing water conservation efforts and increasing water recycling. Water conservation began in the mid-1970s and has allowed the Bay Area population to increase by 23 percent with only a 1 percent increase in overall water use. Water recycling was first used in the Bay Area in 1932, when wastewater was used to irrigate landscape in Golden Gate Park. However, widespread water recycling did not occur until the late 1980s. EBMUD currently supplies the highest amount of recycled water in the Bay Area. In 2005, approximately 30,000 acre-feet per year of recycled water was produced for urban and agricultural irrigation, industrial/commercial needs, and environmental restoration. Recycled water production could expand up to 125,000 acre-feet per year in 2010. Funding and institutional issues limit the amount of water recycling in the Bay Area. Agencies in the Bay Area have been working together to gain State and federal support for water recycling projects since the late 1990s. The Bay Area Regional Recycling Program was developed as part of this effort. Bay Area agencies have received funding for water recycling projects as part of Reclamation's Water Recycling and Reuse Program, Title XVI, include the following projects:

- Pacifica Recycled Water Project - Pipeline, North Coast County Water District
- San Jose Water Reclamation and Reuse Project Phase 1C, South Bay Water Recycling
- South Bay Advanced Recycled Water Treatment Facility, SCVWD
- South Santa Clara County Recycled Water Master Plan Implementation, SCVWD
- City of Hollister recycled water program

Conjunctive Use and Groundwater Banking

Conjunctive use programs have been implemented by several agencies to optimize the use of groundwater and surface water sources.

SCVWD operates an extensive system of in-stream and off-stream artificial recharge facilities to replenish the groundwater basin and provide more flexibility to manage water supplies. Eighteen major recharge systems allow local reservoir water and imported water to be released in over 30 local creeks and 71 percolation ponds for artificial recharge to the groundwater basin. Artificial recharge amounts to approximately 157,000 acre-feet annually (SCVWD 2011). Recharge in this subbasin occurs naturally along streambeds and artificially in in-stream and off-stream managed basins. The operational storage capacity in the basin was estimated with a groundwater flow model at 350,000 acre-feet, and the rate of withdrawal from the basin is a controlling function; pumping should not exceed 200,000 acre-feet in any single year (SCVWD 2001, p. 27). Groundwater recharge with tertiary treated wastewater is being investigated. The use of recycled water for groundwater could occur through direct injection into the basin, or in addition to the existing percolation ponds.

Local runoff from the Alameda Creek watershed accounts for about 40 percent of total water supply in ACWD service area and is used to recharge the Niles Cone subbasin. This runoff, together with water released from the South Bay Aqueduct at a location east of the town of Sunol, flows into the Alameda Creek Flood Control Channel, where the water is captured behind three large, inflatable rubber dams. These dams divert water to the Quarry Lakes, where water percolates to recharge the underlying groundwater basin (ACWD 2011a).

Zone 7 Water Agency artificially recharges the Livermore Valley basin with additional surface water supplies by releasing water into the Arroyo Mocho and Arroyo Valle (Zone 7 2005, p. 3-8). The infiltrated water is then pumped from the groundwater basin for various uses.

ACWD, SCVWD, and Zone 7 Water Agency currently have groundwater banking programs. EBMUD and the City of Napa are investigating opportunities for groundwater banking.

SCVWD reached an agreement with Semitropic WSD to bank up to 350,000 acre-feet in their storage facilities. As of 2001, SCVWD had stored about 140,000 acre-feet in the water banking program (SCVWD 2001, p. 26).

Water Exports and Transfers

Bay Area agencies have continued to develop local and imported water supplies through a number of transfers and exchange agreements as seen in Table 3-10. Water exchanges or transfers can be short-term emergency or drought agreements or long-term purchases of water. In addition, a number of these agencies are water wholesalers with emergency or operational interties.

Table 3-10
San Francisco Bay Area Water Supply Transfers and Exchange Agreements and System Interties

Bay Area Water Supply and Conservation Agency Member Agencies' Interties	Emergency interconnections throughout the 25 individual agency systems.
CCWD and CCWD's Wholesale Customer Interties	Emergency interties including one raw water intertie with EBMUD and treated water interties between and among CCWD and its retailers include Diablo Water District-Antioch; Diablo Water District -Brentwood; Pittsburg–Southern California Water Company (Bay Point); Pittsburg-Antioch; CCWD-Antioch (via multipurpose pipeline); CCWD–Southern California Water Company; CCWD-Martinez; CCWD-EBMUD
CCWD/ East Contra Costa ID Purchase Agreement	CCWD has an agreement with East Contra Costa ID to purchase water during droughts.
City of Napa Interties	Emergency intertie connections with the cities of American Canyon, Calistoga, and St. Helena, and the Town of Yountville.
CVP and SWP Water Transfers	SCVWD participates in short-term water transfers and exchanges with other SWP and CVP contractors on a routine basis to manage supplies from one contract year to the next.
DWR Drought Bank	ACWD, SFPUC, and SCVWD have participated in this bank to provide supply during long-term droughts. During the 1970s drought, SFPUC bought water from DWR and Kern County Water Bank.
EBMUD-CCWD Interties	One inactive one-way raw water intertie, one small treated water intertie, one raw water intertie between Los Vaqueros Pipeline and the Mokelumne Aqueduct, and two small interties with city of Hayward. The Los Vaqueros/Mokelumne intertie agreement permits conveyance of up to 10 mgd of water from EBMUD to CCWD and about 8 mgd of water from CCWD to EBMUD.
EBMUD-SFPUC Intertie	Emergency 30-mgd intertie between EBMUD and SFPUC (in City of Hayward)
Marin Municipal Water District–Sonoma County Water Agency Supply Connection	Connection to supply water to Marin Municipal Water District through Sonoma County Water Agency system
Mojave Exchange Agreement	Solano County Water Agency has an agreement with Mojave Water Agency (MWA) for storage of wet weather flows in exchange for dry weather flows. Up to 10,000 acre-feet can be stored in any one year as part of this program. The City of Benicia is the only local agency that has participated in this program. It has a total of 5,500 acre-feet banked with MWA.
North Marin Water District/ Marin Municipal Water District intertie	Allows transfer of surplus water between agencies.
SCVWD Water Transfers	SCVWD regularly purchases water when SWP allocations are low through a number of different transfer agreements.
SCVWD-SFPUC Intertie	Emergency 40-mgd intertie between SCVWD and SFPUC (in Milpitas)
Solano County Water Contractors Water Transfer Agreement	Solano County Water Agency has agreements for water transfers within the group of agency water contractors, including the Solano Irrigation District City Agreements, the Solano Project Drought Measures Agreement, and the Vallejo Agreements.
Zone 7 Water Agency/ Byron Bethany Irrigation District Purchase Agreement	Zone 7 Water Agency also has a 15-year contract (renewable for another 15 years at Zone 7's option) with Byron Bethany Irrigation District to provide up to 5,000 acre-feet per year of additional supply.

Source: BAWAC 2006a

Water Supply Reliability

In general, the Bay Area has adequate supplies to meet regional needs; however, water quality improvements continue to be a focus of the water agencies in the area.

Two issues affect existing water supply reliability: (1) reduction in surface storage from sedimentation and (2) reductions in Delta or local water supplies due to climatic conditions. Loss of reservoir storage is significant because there are over 30 reservoirs, which store more than 800,000 acre-feet of local and imported water. Sonoma County Water Authority is already experiencing gradual loss of storage capacity in the reservoirs on the Russian River caused by erosion and sedimentation (BAWAC 2006b, p. 35). Climatic changes affect inflows to the Delta by reduced or increased rainfall and runoff, which exacerbates runoff and sedimentation (wet years) and increases tidal inflows to the Delta (dry years). In 1994, six SWP contractors and DWR created the Monterey Agreement. The purpose of this agreement was to increase the reliability of SWP water and increase water management flexibility during periods of water shortage (DWR 2009a, p. SF-9).

3.3.5.3 Central Coast

The Central Coast encompasses the southern planning area of the Central Coast Hydrologic Region (DWR 2009a, p. CC-6) and covers San Luis Obispo and Santa Barbara counties. The region consists of coastal plains, inland valleys, and portions of the Coast Ranges. The major land uses in the area are agriculture and federally held lands (including Los Padres National Forest and Vandenberg Air Force Base). Agriculture in the area ranges from orchards and vineyards to row crops and ranching.

The Central Coast has a Mediterranean climate with mild, wet winters and warm, dry summers. Precipitation occurs primarily between November and April with average annual precipitation historically ranging from 12 to 42 inches between 2005 and 2008 (DWR 2009a, p. CC-8). Rainfall varies from 50 inches in the mountains and 5 to 10 inches in the inland valleys.

3.3.5.3.1 Surface Water Hydrology

Surface water sources in the Central Coast consist of water from the Huasna, Cuyama, Santa Inez, Santa Maria, and Sisquoc rivers, which are stored in Reclamation's Cuyama and Santa Maria Projects, USACE's Whale Rock and Salinas Reservoirs, Lake Lopez on Arroyo Grande Creek, and the Monterey County Water Resources Agency's Lake Nacimiento. Several of these projects or reservoirs were developed for flood control but have water supply benefits as well.

The Santa Maria River is formed by the confluence of the Cuyama and Sisquoc rivers at Fugler Point, 20 miles inland from the coast. The Cuyama River drains southeastern San Luis Obispo County, northeastern Santa Barbara County, and small portions of Ventura and Kern counties. Major tributaries to the Cuyama River are Huasna River and Alamos Creek. The Cuyama River and its tributaries have intermittent flows, although some reaches of the river have surface water most of the year. The Santa Ynez River and its tributaries supply water to over two-thirds of the Santa Barbara County. The Santa Ynez River originates in the San Rafael Mountains in the Los Padres National Forest near the eastern border of the county with a small portion in Ventura County. The river flows westerly about 90 miles to the ocean, passing through Jameson Lake (5,290 acre-feet), Gibraltar Reservoir (7,000 acre-feet), and Lake Cachuma (189,000 acre-feet) (Santa Barbara County 2007, p. 4-10).

3.3.5.3.2 Surface Water Quality

Water quality issues in the Central Coast area include nutrients, pathogens, bacteria, TDS, and nitrates. There are a number of adopted TMDLs or TMDLs under development to address these concerns:

- The San Luis Obispo Creek Nutrient TMDL was adopted in 2005 that sets an objective for nitrate expressed as nitrate.

- The San Luis Obispo Creek Pathogen TMDL was adopted in 2005 that sets a maximum limit for fecal coliform.
- The Central Coast RWQCB has begun developing a TMDL for bacteria and nitrates in the Santa Maria River Basin. In addition, the RWQCB is developing a watershed-wide TMDL for all pollutants (more than 90) in the Santa Maria River watershed.
- The Chorro Creek Nutrients and Dissolved Oxygen TMDL was approved July 19, 2007, by USEPA.
- The Dairy Creek Dissolved Oxygen TMDL was approved by the RWQCB on December 3, 2004.
- The Las Tablas Creek and Lake Nacimiento Mercury TMDL was approved by the RWQCB on May 16, 2003.
- The Los Osos Creek, Warden Creek, and Warden Lake Wetland Nutrient TMDL was approved by USEPA on March 1, 2005.
- The Morro Bay (Including Chorro and Los Osos Creeks) Pathogen TMDL was approved by USEPA on November 19, 2003.
- The Morro Bay (Including Chorro Creek, Los Osos Creek and the Morro Bay Estuary) Sediment TMDL was approved by USEPA on December 3, 2003.

The importation of water from the Delta through the SWP, with lower salt content than local sources, improves basin water quality. In the Santa Maria basin, water quality is improved through recharge operations of Twitchell Reservoir and SWP water importation, which provide higher-quality water. In the Santa Ynez River watershed, under the Cachuma Project Settlement Agreement, SWP water is mixed with water rights releases from Bradbury Dam to lower the salt content of flows downstream.

3.3.5.3.3 Groundwater Hydrology

The Central Coast Hydrologic Region includes 50 delineated groundwater basins, as defined by DWR (DWR 2003, p. 140). The basins vary from large extensive alluvial aquifers to small inland valleys and coastal terraces. Groundwater in the large alluvial aquifers occurs in thick unconfined and confined aquifers. Groundwater in the smaller valleys occurs in thinner unconfined aquifers (DWR 2009a, p. CC-15). Only a few of the DWR groundwater basins underlie areas supplied with Delta water.

Most of the groundwater production occurs in the coastal aquifer, though a few large inland valley groundwater basins also provide high yields (Cuyama Valley and Paso Robles area). Production from these basins is tied to groundwater recharge from natural sources (precipitation and stream seepage) and from artificial sources such as reservoir releases to creeks and rivers. Groundwater levels in most coastal basins are below sea level, which increases the potential for seawater intrusion into the freshwater aquifers. However, in some areas, faults provide a protection against seawater intrusion by forming a groundwater barrier with uplifted rock (such as in the Goleta Basin).

Several groundwater basins in Santa Barbara County are in a state of overdraft, including the Cuyama, San Antonio, and Santa Ynez basins. Other basins are in equilibrium due to management of the basin through conjunctive use by local water districts (Santa Barbara County 2007, p. 2-21). The Goleta Basin generally is near or above historical groundwater conditions (Goleta Groundwater Basin and La Cumbre Mutual Water Company 2010, p. 2-6), with the northern and western portions of the basin having groundwater levels near the ground surface. High groundwater levels may result in degradation to building foundations and agricultural crops (water levels within the crop root zone).

The Santa Maria Basin, which is one of the major groundwater supplies in the area, is located partially in San Luis Obispo County and partially in Santa Barbara County. Groundwater levels in this basin have fluctuated significantly since the 1920s, marked by seasonal and long-term trends of decline and recovery. Declines of up to 100 feet in both the shallow and deep aquifer zones were observed between 1945 and the late 1960s. The groundwater levels have generally recovered to near historically high levels after periods of decline, as recently as 2002. However, in the last decade, groundwater levels in both the shallow and deep zones have gradually declined, and are most visible in portions of the Sisquoc Valley and Oso Flaco areas. Recent groundwater level declines can be attributable, at least partially, to reductions in Twitchell Reservoir releases for in-stream supplemental groundwater recharge since 2000 (including no releases in 2009). Coastal groundwater levels remain above sea level, which indicates that enough recharge is occurring to prevent seawater intrusion (Santa Maria Valley Management Area 2010, p. 8-9).

Groundwater quality issues in the Central Coast area include nitrates, salinity, hardness, and perchloroethylene (PCE). In the Santa Maria Valley groundwater basin, sulfate and TDS are the primary constituents of concern. TDS concentrations range from approximately 750 mg/L to 1,300 mg/L, with a median of 1,200 mg/L, which exceeds the drinking water standard. All the sulfate concentrations exceeded the recommended drinking water standard of 250 mg/L, and some exceeded the upper limit of 500 mg/L. PCE contamination was a major issue for two wells used by the City of San Luis Obispo in the late 1980s (San Luis Obispo County 2011, p. 3-60).

In addition, seawater intrusion has been observed more than 5 miles inland in some areas (DWR 2003, p. 140). In Santa Barbara County, groundwater basins in Santa Barbara and near Santa Maria have experienced signs of seawater intrusion; however, it does not currently present a threat to drinking water supplies. The seawater intrusion was caused by heavy pumping from municipal wells and a groundwater level drop of up to 100 feet in the late 1970s. Effective pumping practices and injection programs have effectively helped reverse the seawater intrusion trend (Santa Barbara County 2007, p. 2-28). Also, some basins are affected by poorer quality water originating in the deep connate formation and leaking through fractured bedrock zones and induced by excessive groundwater pumping (Santa Barbara County 2007, p. 2-32).

Santa Barbara County contains a number of non-sewered, fairly densely populated areas that remain on septic tanks, requiring integrated action by the Local Agency Formation Commission, cities, and special districts to provide for extensions of sewer systems to serve these areas or other measures to address potential groundwater contamination. State MCLs for nitrates already have been exceeded in some areas, and methyl tertiary butyl ether and chlorinated solvents pose problems for some wells (Santa Barbara County 2007, p. 2-27).

There is significant interaction between surface water and groundwater in the Central Coast, particularly along creeks and rivers. Local agencies operate surface water reservoirs to increase natural recharge by releasing water to recharge downstream groundwater basins. Groundwater recharge is achieved through the operation of several reservoirs: Hernandez Reservoir, Twitchell Reservoir, Lake San Antonio, and Lake Nacimiento. The operation of these reservoirs allows for a continued stream flow over a longer period to increase the infiltration of surface water to the aquifers (DWR 2003, p. 140). For example, Twitchell Reservoir is operated to recharge downstream groundwater basins in the Santa Maria Valley with up to 20,000 acre-feet per year of water (Santa Barbara County 2007, p. 4-17). Lopez Reservoir is operated to supply 4,200 acre-feet per year of water for downstream recharge to groundwater basins. Groundwater recharge occurs primarily from April to October.

3.3.5.3.4 Water Use and Infrastructure

Irrigated agriculture represents the dominant water use, accounting for 66 percent of regional water use between 1998 and 2005. The remaining 34 percent of water use is split between urban (26 percent) and environmental uses (8 percent) (DWR 2009a, Technical Appendix 6).

Water suppliers in the region are investigating several projects to increase water supply in the region, increase recharge, and increase the amount of water available for environmental uses. Water supply reliability is reduced during prolonged droughts by reduced imported water supplies, declining groundwater levels, and reduced local supplies and storage. Potential projects include increasing storage in Salinas Reservoir, increased recycled water use, and pipelines from Lake Nacimiento to San Luis Obispo.

Surface Water Use

Several surface water projects have been developed to provide surface water resources to local users.

In 1956, the Santa Maria Project was developed to control the flows in the Cuyama River through construction of Twitchell Reservoir, which has a capacity of 224,300 acre-feet. This reservoir retards a portion of intercepted floodwaters of the Cuyama River, which are released as needed to recharge the Santa Maria groundwater basin and to prevent saltwater intrusion. Average releases are approximately 32,000 acre-feet per year for recharge of the groundwater basin (Reclamation 2011b).

Lake Cachuma was constructed in 1956 to store floodwaters for water supply. This project supplies water to Goleta, Montecito, Summerland, and Carpinteria water districts, and to municipal users in the City of Santa Barbara. In 1997, Lake Cachuma was connected to the SWP via the Coastal Branch Feeder (Santa Barbara County 2007, p. 3-8).

Whale Rock Reservoir was constructed on Old Creek in 1960 to supply water to the City of San Luis Obispo, Cal Poly State University, and California Men's Colony. The Salinas Reservoir was constructed to store water from the Salinas River to the decommissioned Camp San Luis Obispo and the City of San Luis Obispo. The Salinas Reservoir can store over 23,843 acre-feet, and the Whale Rock Reservoir can store over 40,662 acre-feet of water (City of San Luis Obispo 2005, pp. 13, 21).

Lake Lopez stores over 49,388 acre-feet of water from the Arroyo Grande Creek for water supply (San Luis Obispo County Flood Control and Water Conservation District 2005, p. 9). The lake serves water to the cities of Arroyo Grande, Grover Beach, Pismo Beach, Oceano, and Avila Beach. The safe yield from the reservoir is 8,730 acre-feet per year, of which 4,530 acre-feet per year are provided to five contractors and 4,220 acre-feet per year is reserved for downstream releases to maintain stream flows and groundwater recharge downstream (San Luis Obispo County Flood Control and Water Conservation District 2005, p. 10).

Lake Nacimiento was constructed to provide flood control on the Salinas River and water supply to San Luis Obispo and Monterey counties. The Lake is operated by the Monterey County Water Resources Agency and has a capacity of over 300,000 acre-feet. However, San Luis Obispo County has rights to approximately 17,000 acre-feet (City of San Luis Obispo 2005, p. 28). This water is used as a supply to the cities of Paso Robles, Atascadero, Templeton, San Luis Obispo, and Cayucos.

Imported Water

In 1963, the Santa Barbara County Flood Control and Water Conservation District contracted with DWR to deliver 57,700 acre-feet per year of SWP water to Santa Barbara County. In 1981, the original contract was amended to reduce Santa Barbara County's State water contract amount to 45,486 acre-feet per year. This amount was further modified in 1984 to include 39,078 acre-feet per year for Santa Barbara County and 4,830 acre-feet per year for San Luis Obispo County, 3,908 acre-feet per year of drought buffer, and 2,500 acre-feet per year of a special drought buffer for the Goleta Water District. In 1991, several service areas in Santa Barbara County voted to import SWP water including Carpinteria, Summerland, Montecito, Santa Barbara, Hope Ranch, Goleta, Buellton, Solvang, Santa Ynez, Orcutt, and Guadalupe. The Santa Maria City Council and Vandenberg Air Force Base also decided to participate in the SWP.

Beginning in 1997, the Central Coast Water Authority began to deliver SWP water to Lake Cachuma via the Coastal Aqueduct.

The Coastal Aqueduct, which branches off the California Aqueduct, was completed in 1997. The aqueduct consists of 143 miles of pipeline, a water treatment plant, storage tanks, and pumping facilities. The aqueduct consists of the 101-mile long DWR Coastal Branch pipeline from Kern County to Vandenberg Air Force Base and the 42-mile long Central Coast Water Authority pipeline from Vandenberg AFB to Lake Cachuma. The aqueduct can supply up to 47,816 acre-feet per year of SWP water (DWR 1997, p. 3).

Environmental Water Use

Environmental water requirements in the Central Coast area are approximately 8 percent of total water use in the region. This water is used to meet habitat needs in the Sisquoc River, the Arroyo Grande Creek, and the Santa Ynez River.

Environmental water requirements include downstream needs for habitat below Lopez Reservoir. A habitat conservation plan has been developed for this area with objectives to follow an in-stream flow schedule in Arroyo Grande Creek, using managed releases from Lopez Reservoir to (1) enhance in-stream habitat for steelhead, (2) reduce or avoid adverse impacts from dewatering steelhead habitat, and (3) reduce or avoid adverse impacts of in-stream flows on red-legged frog habitat.

A 33-mile portion of the Sisquoc River in Santa Barbara County has been designated as a Wild and Scenic River. The designated segment is mostly within the San Rafael Wilderness and in 2005 had an unimpaired runoff of over 47,000 acre-feet (DWR 2009a, p. CC-13).

The Lower Santa Ynez River Fish Management Program was implemented to provide projects and management strategies to protect, enhance, restore, and create new habitat for the spawning and rearing of endangered steelhead. The Cachuma Conservation Release Board and the Santa Ynez River Water Conservation District ID No.1 fully fund the Fish Management Plan and implement the NMFS Cachuma Project Biological Opinion (Cachuma Conservation Release Board 2011). Water releases from Lake Cachuma to the Lower Santa Ynez River allow for increased groundwater recharge, satisfy water rights requirements, and provide sufficient in-stream flows to satisfy fisheries (Santa Ynez River Technical Advisory Committee 2000, pp. 2-8–2-9).

Groundwater Use

Groundwater is an important source of water supply for the population of the Central Coast; it is the region’s primary water source. In 1995, groundwater provided approximately 83 percent of the annual water supply for agricultural and urban uses (DWR 2003, p. 140). In general, this region uses about 8.4 percent of the groundwater supply in the state.

Groundwater supplies are from the San Luis Obispo, Los Osos, and the Santa Maria groundwater basins. The city of San Luis Obispo receives water from the San Luis Obispo Valley groundwater basin. The Los Osos basin serves water to the Golden State Water Company, S&T Mutual, the Los Osos Community Services District (CSD), and overlying users. The Santa Maria River Valley groundwater basin supplies the City of Santa Maria, City of Pismo Beach, City of Arroyo Grande, City of Grover Beach, Oceano CSD, small public water systems (including Halcyon Water System), Lucia Mar Unified School District, Golden State Water Company, Rural Water Company, Woodlands, Conoco Phillips, Nipomo CSD, and residential and agricultural overlying users. In Santa Barbara County, over two-thirds of water supplied is from the Santa Ynez River Valley basin, and the major water user is the City of Santa Barbara.

Water Recycling and Water Conservation

Recycled water is used throughout the Central Coast for urban and agricultural irrigation as well as industrial purposes. The City of San Luis Obispo delivers 135 acre-feet per year of recycled water to irrigation users including golf courses, schools, and commercial establishments, and the city has plans to deliver up to 1,000 acre-feet per year (San Luis Obispo County 2011, p. 3-93). Recycled water is also produced for irrigation on the Dairy Creek Golf Course from the California Men's Colony (San Luis Obispo County 2011, p. 3-89). The Laguna County Sanitation District produces approximately 2,400 acre-feet per year of recycled water, which is used for agricultural, landscaping, and industrial purposes (Santa Barbara County 2007, p. 2-19). The City of Santa Barbara, the Goleta Sanitary District, City of Lompoc, and the Los Alamos CSD treat a portion of their flow to tertiary levels for landscape irrigation. The City of Santa Barbara El Estero Wastewater Treatment Plant can supply up to 1,200 acre-feet per year of tertiary effluent, but currently treats only 800 acre-feet per year (Santa Barbara County 2007, p 2-19). The Goleta Sanitary District recycled water system is operated jointly with the Goleta Water District (who acts as the purveyor). The Goleta Water District can supply up to 1,500 acre-feet per year of tertiary effluent but the existing demand is only 1,000 acre-feet per year (Santa Barbara County 2007, p 2-19). The City of Lompoc utilizes approximately 5 acre-feet per year of its secondary treated effluent for reuse and discharges to the Santa Ynez River. The Los Alamos CSD discharges all of its approximately 130 acre-feet per year of secondary effluent for pasture irrigation (Santa Barbara County 2007, p. 2-19).

Seawater Desalination

A reverse osmosis desalination plant was constructed in 1992 by the City of Santa Barbara, Goleta Water District, and Montecito Water District as an emergency water supply in response to the severe drought lasting from 1986 to 1991 (Santa Barbara County 2007, p. 4-11). The latter two agencies are no longer participants in the desalination plant, which is currently decommissioned due to ample quantities of less-expensive water supplies. The desalination facility can, however, be brought into operation within 6 to 12 months, if needed, during drought or water shortage conditions (Santa Barbara County 2007, p. 4-11). Just over half of the prefiltration capacity and reverse-osmosis treatment modules were sold, leaving sufficient capacity to meet the City's anticipated need for approximately 3,000 acre-feet per year of production in future droughts (Santa Barbara County 2007, p. 4-11). Another desalination plant is in the planning stages for the Oceano area. The Arroyo Grande, Grover Beach, and Oceano CSD have studied implementing a 1.7-mgd desalination project to increase water supply.

3.3.5.4 Southern California

The Southern California area has three climatic regions: coastal, mountains/high desert, and inland valleys. The coastal area includes Los Angeles, Orange, and San Diego counties; the inland valleys include Ventura County and the Inland Empire area; and the mountain/high desert area includes Antelope Valley, Mojave Valley, Coachella Valley, and portions of the mountainous areas of Kern, San Bernardino, and Los Angeles counties.

Southern California has a semiarid climate with warm wet winters and dry hot summers. On average, between 10.8 and 15.9 inches of precipitation occurs annually (usually between November and March). Precipitation rates can vary annually by more than 100 percent (Metropolitan 2005, p. 1-11), and large storm events carry a majority of the precipitation that occurs in the region. These storms run into the mountain ranges, which surround the coastal valleys to the east, releasing large quantities of water. This water flows from the mountains dropping over 10,000 feet (in some areas) to the coastal plain (USACE 2003, p. 4-1) before flowing to the ocean. The coastal and interior valleys feature Mediterranean climates characterized by mild, wet winters, and warm, dry summers. These valleys receive approximately 10 inches of rain annually. The mountains bordering the south coastal areas have climates that range from Mediterranean to subtropical steppe, with a high range of temperatures. Average annual precipitation may be 40 inches or higher in the mountains, and in the desert valleys precipitation is generally 10 inches or less. Portions of the eastern Mojave Desert average 4 inches of precipitation annually (DWR 2009a, p. SL-12).

3.3.5.4.1 Surface Water Hydrology

There are 18 major rivers, streams, and creeks in the Southern California area. A majority of these have headwaters in the mountains and flow down to the valley floor and out to the ocean over the coastal plains. In general, the headwaters of the watercourses are in undeveloped areas, and the downstream reaches are in highly urbanized areas. During much of the year, rivers and streams either dry up or have reduced flows except during storm events, when flows peak and flooding can occur. For this reason, many watercourses in the region have been channelized and some lined with concrete, particularly in highly urbanized coastal areas, to protect against flooding. Precipitation contributes most of the annual volume of stream flow to the waterways. However, urban runoff, wastewater discharges, agricultural tailwater, and groundwater seepage are sources of surface flows during the dry season. During the past 30 years, dry weather flows have increased due to increased runoff from urban development (DWR 2009a, p. SC-22).

The amount of water available from runoff capture and stream flow diversion varies based on climatic conditions, geologic conditions, land use, and stormwater management. For example, over 80 percent of the Santa Ana and San Gabriel rivers' flow is captured and stored in surface or groundwater reservoirs, but only approximately 20 percent of flows in the Los Angeles River are captured (Metropolitan 2010, A.2-1). There is less flow captured in the Los Angeles River because it is located in a highly urban area, 90 percent of the channel has been lined with concrete that prevents natural recharge, large flow events occur during storms and are difficult to capture, and there is limited space for additional reservoirs or recharge basins. In contrast, the Santa Ana and San Gabriel rivers are mostly unlined, have in-stream and off-stream groundwater recharge basins, and have flood control reservoirs that manage storm events.

Major rivers in Southern California include the following:

- Calleguas Creek drains the 343-square-mile Oxnard Plain starting in eastern Ventura County and flowing westward to the Mugu Lagoon (DWR 2009a, p. SC-7).
- Ventura River drains a 228-square-mile watershed from the upper slopes of the Transverse Range south to an estuary north of the City of Ventura (DWR 2009a, p. SC-7).
- Santa Clara River drains a 1,600-square-mile watershed from the northern slopes of the San Gabriel Mountains westward to the City of Oxnard. This river is the most natural in the southern California region with a majority of the watershed being undeveloped. The river has intermittent flows that are augmented with releases from Lake Piru during dry months (DWR 2009a, p. SC-7).
- Los Angeles River drains a 343-square-mile watershed from the San Gabriel Mountains flowing southwest into the San Pedro Bay near Long Beach. The Los Angeles River is a concrete-lined channel for 48 miles of its 51-mile length (USACE 2001, p. 4-2). The river's major tributaries include Burbank Western Channel, Pacoima Wash, Tujunga Wash, and Verdugo Wash in the San Fernando Valley; and the Arroyo Seco, Compton Creek, and Rio Hondo south of the Glendale Narrows. The current flow in the river is effluent-dominated with approximately 80 percent of its flow originating at dischargers and the remainder coming from storm drain runoff and groundwater reaching the surface (USACE 2001, p. 4-2).
- San Gabriel River drains a 680-square-mile watershed in eastern Los Angeles County and northwestern Orange County. It flows from its headwaters in the San Gabriel Mountains through the San Gabriel Valley before crossing the coastal plain and emptying into San Pedro Bay near Seal Beach. The river's major tributaries include Coyote Creek, Dalton Creek, San Dimas Wash,

San Jose Creek, and Walnut Creek. The river was channelized and the sidewalls lined with concrete or grouted stone to control the runoff and reduce the impact of catastrophic flooding in the region. In addition, a portion of the river in the middle of watershed was lined with concrete to protect heavily urbanized areas. The flow of the San Gabriel River is regulated by the Los Angeles County Department of Public Works (LACDPW) to maximize groundwater recharge. The water is used to artificially recharge groundwater at 27 spreading facilities located along the San Gabriel River and some of its tributaries (USACE 2001, p. 4-3).

- Santa Ana watershed drains 2,800 square miles from the San Gabriel and San Bernardino mountains in the north to the Pacific Ocean in the south. The river carries runoff from the mountains and high desert to the Prado Dam, where it flows south to the coastal plain. The river is intermittent in a natural state but flows year-round with highly treated effluent discharges. The headwaters of the river are in undeveloped areas, and portions of the river downstream of Prado Dam have been partially channelized to protect densely populated areas of Orange County (USACE 2002, p. 3).
- Santa Margarita River drains a 450-square-mile watershed flowing northeast to southwest. The river originates near Temecula Valley in Riverside County and flows into the Pacific Ocean near the City of Oceanside. The river is an intermittent stream terminating in an estuary. The lower reaches of the watershed (approximately 60 square miles) have remained relatively undeveloped because they are on lands within Camp Pendleton Marine Corps Base (DWR 2009a, p. SC-10).
- San Diego River drains a 440-square-mile watershed from its headwaters in the Volcon and Cuyamaca Mountains flowing westward to the Pacific Ocean near Ocean Beach. Four reservoirs in the watershed store imported water: El Capitan, San Vicente, Lake Jennings, and Cuyamaca, as well as Lake Murray, which captures natural runoff, and the Santee Lakes, which are effluent-dominated (DWR 2009a, p. SC-11).
- Tijuana River originates in Mexico before entering the United States for the last 5 river miles and flowing into the Pacific Ocean. In the United States, the river’s quality is degraded due to upstream effluent discharges (DWR 2009a, p. SC-12).
- Mojave River originates in the San Bernardino Mountains and flows northeast 120 miles, where it terminates into Silver Dry Lake near Baker. The river is intermittent, flowing underground at times, and fills during storm events. There are a number of dry lakebeds, and the Mojave River Dam captures storm flows and natural runoff. (DWR 2009a, p. SL-8)

More than 75 water-impoundment structures in Southern California capture runoff and storm flows and some store imported water.

3.3.5.4.2 Surface Water Quality

Salinity is one of the main water quality issues faced by importers of surface water supplies. It is of greatest concern in Colorado River Aqueduct (CRA) supplies; however, it also is a concern in groundwater and to the SWP during droughts. If seawater intrusion continues to occur in the Delta, salinity impacts to Delta water users would be significant. The water quality delivered through the SWP in the East and West branches of the California Aqueduct ranges from 75 to 470 mg/L of TDS (Reclamation 2006b, Volume III: Section 4, p. 248). High salinity results in less water being available for use because of losses in treatment plant processes (up to 15 percent) required to reduce TDS concentrations. Salinity also affects recycled water use because it must either be removed for some uses, or be reduced to prevent habitat, plant, and groundwater degradation. High salt concentrations can affect crop yield by reducing or increasing the ability of minerals and nutrients to be absorbed by the plant and, thereby, adversely affect growth rates.

Colorado River water must be blended with other water supply sources to meet MCLs for drinking water as well as meet public acceptance because of its salinity. Currently, CRA water (TDS average of 630 mg/L since 1976) is blended with SWP water (average of 250 mg/L in East Branch and 325 mg/L in West Branch) to meet the 500 mg/L TDS salinity objective (Metropolitan 2005, p. IV-3).

TOC and bromides are constituents of concern in the SWP. TOC and bromide found in the Delta originate from seawater intrusion, agricultural drainage, wastewater discharges, and naturally occurring sources. These constituents are important because when they treated using disinfectants (such as chlorine or ozone), disinfection byproducts form. Currently, this water is either treated using ozonation or blended with CRA water or groundwater to meet water quality objectives to reduce or limit the formation of disinfection byproducts.

Stormwater quality also is of concern in the area. Water quality issues in Southern California are caused by human-made and natural sources. Bacteria, metals, trash, nutrients, sediment, salts, nitrate, organochlorine compounds, diazinon, chlorpyrifos, and selenium are common water quality concerns. The RWQCBs of Colorado River, Los Angeles, Lahontan, Santa Ana, and San Diego have developed a number of TMDLs to address water quality concerns from urban runoff and have adopted the following TMDLs:

- San Diego RWQCB: Chollas Creek Diazinon; Chollas Creek Copper, Lead, and Zinc; Rainbow Creek Nitrogen and Phosphorus; Shelter Island Yacht Dissolved Copper; and Indicator Bacteria TMDLs
- Los Angeles RWQCB (Los Angeles and Ventura Counties):
  - Bacteria TMDL for the Los Angeles River, Santa Clara River, Ballona Creek, Ballona Estuary, and Sepulveda Channel, Marina del Rey Harbor Mothers’ Beach and Back Basins, Santa Monica Bay Beaches Wet Weather, Santa Monica Bay Beaches Dry Weather, Malibu Creek, Los Angeles Harbor, and Marina del Rey Basins
  - Trash TMDL for Ballona Creek, Los Angeles River Watershed, Machado Lake, Malibu Creek, Legg Lake, Lake Elizabeth, Munz Lake, and Lake Hughes, Ventura River Estuary, Revolon Slough & Beardsley Wash, and San Gabriel East Fork
  - Nutrient TMDL for Los Angeles River, Santa Clara River, and Harbor Beaches of Ventura County
  - Metals TMDL for Ballona Creek, Los Angeles River, and Calleguas Creek Watershed
  - McGrath Lake PCBs, Pesticides and Sediment Toxicity
  - Colorado Lagoon Pesticides, polycyclic aromatic hydrocarbons, PCB, Metals
  - Upper Santa Clara River Chloride
  - Calleguas Creek Nitrogen and Watershed Salts
  - San Gabriel River Metals and Selenium
  - Marina del Rey Harbor Toxics
  - Calleguas Creek OC Pesticides and PCBs
  - Calleguas Creek Toxicity
  - Ballona Creek Estuary Toxic Pollutants

- Santa Ana RWQCB (Orange County and the Inland Empire): Nutrient for Big Bear Lake and Lake Elsinore and Canyon Lake; Metals for Big Bear Lake and San Diego Creek and Newport Bay; Bacteria indicators for Middle Santa Ana River Watershed Waterbodies and Knickerbocker Creek; Santa Ana River Reach 3 Nitrate; Lower Newport Bay, Rhine Channel Organochlorine Compounds and Metals; San Diego Creek/ Newport Bay Selenium; Newport Bay Fecal Coliform; San Diego Creek /Newport Bay Sediment; San Diego Creek /Newport Bay Organochlorine Compounds; San Diego Creek and Upper Newport Bay Diazinon and Chlorpyrifos
- Lahontan RWQCB (Mojave Valley): Haiwee Reservoir Copper
- Colorado River RWQCB (Coachella Valley): New River, Imperial Valley Drains, and Alamo River Sedimentation/Siltation; New River Pathogen; New River Trash

The following TMDLs are in process:

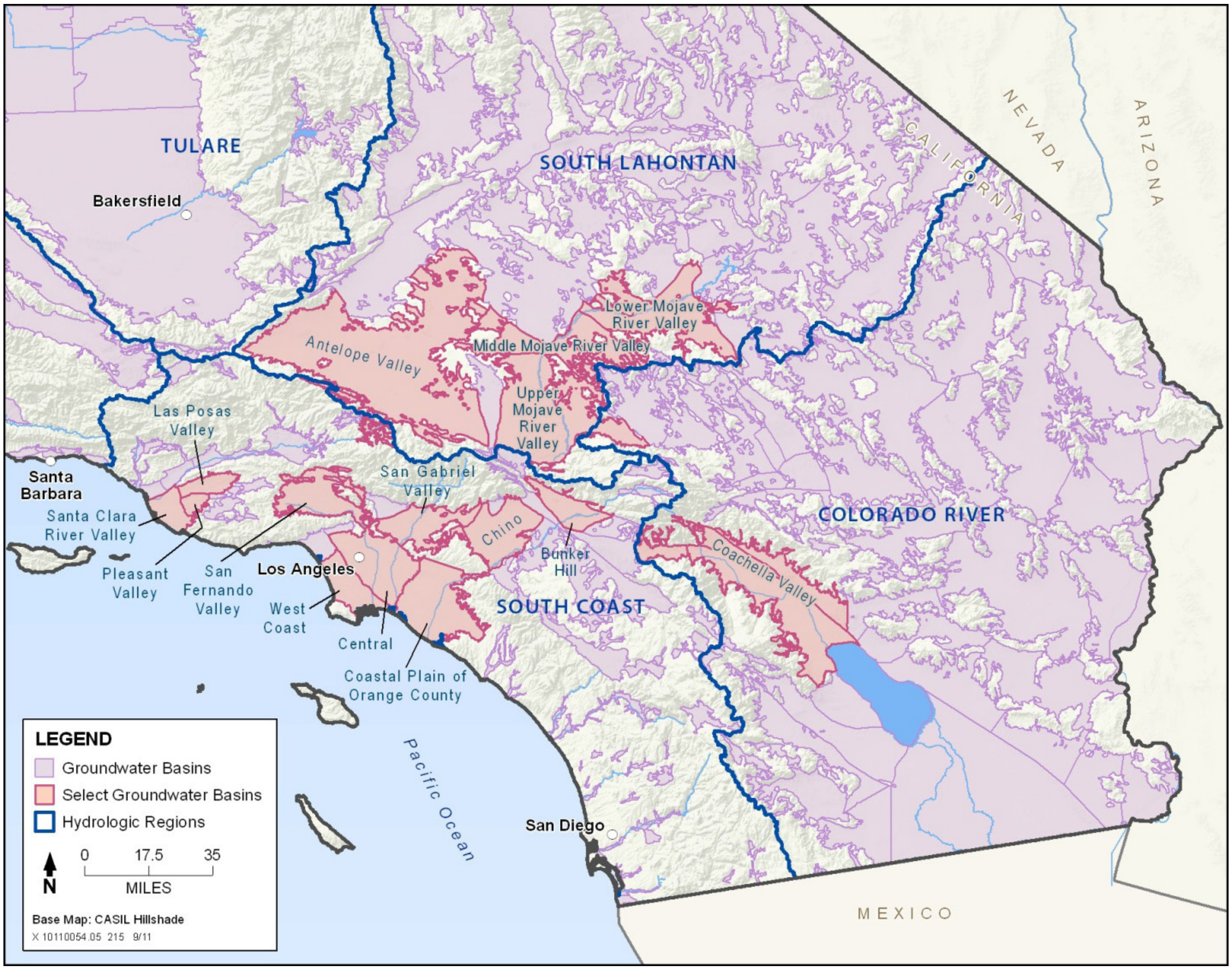
- San Diego Region: San Diego Marine Sediments; Impaired Lagoons, Beaches, and Agua Hedionda; and Tijuana River Estuary
- Los Angeles and Ventura Region: Machado Lake Toxics; Calleguas Creek, its Tributaries, and Mugu Lagoon Toxicity, Chlorpyrifos, and Diazinon; Ventura River Algae; Santa Monica Bay Nearshore Debris; Los Angeles and Long Beach Harbors Toxic and Metals; Malibu Creek Nutrient; Colorado Lagoon Toxicity; Calleguas Creek Metals and Selenium; Machado Lake Nutrients
- Santa Ana Watershed (Orange County and the Inland Empire): Big Bear Lake and Tributaries Nutrient; Big Bear Lake Mercury
- Colorado River Basin: Bacterial Indicators in the Coachella Valley Stormwater Channel; New River Dissolved Oxygen, New River Volatile Organic Compounds, Palo Verde Outfall Drain Bacterial Indicators; Salton Sea Nutrient

3.3.5.4.3 Groundwater Hydrology

Southern California includes the groundwater basins of the South Coast Hydrologic Region, as well as portions of the South Lahontan Hydrologic Region, and the Colorado River Hydrologic Region as defined in DWR Bulletin 118-03 (see Figure 3-7). Groundwater occurs in unconfined alluvial aquifers in most of the basins in the South Coast Hydrologic Region. Confined groundwater conditions exist in areas underlying the coastal plains, where multiple aquifers might be separated by aquitards (DWR 2003, p. 149). The South Lahontan Hydrologic Region is sparsely populated and little groundwater development exists in most areas (DWR 2003, p. 194). Several fault zones in Southern California impede groundwater flow in certain areas.

Some of the groundwater basins in Southern California are brackish or have other water quality issues that require additional treatment prior to use. Groundwater quality is degraded through increased salinity and other constituents (such as nitrate) introduced by agricultural and municipal activities, past industrial/commercial activities, seawater intrusion, or from naturally existing conditions. In addition, the use of imported Colorado River water with higher salinities has resulted in degradation of groundwater quality in much of Southern California. Brackish groundwater exists primarily in the San Diego region, areas of the Inland Empire, and coastal areas of Los Angeles and Orange Counties. In addition, high TDS levels are a problem in Coachella Valley. Groundwater quality in the Antelope Valley basin is affected by high levels of nitrate and boron (DWR 2004j, p. 3).

Figure 3-7
Groundwater Basins in the Southern California
Source: DWR 2003



The South Coast Hydrologic Region extends from the San Gabriel and San Bernardino mountains to the boundary with Mexico. The groundwater basins are divided into three regions by DWR: the Los Angeles subregion, the Santa Ana subregion, and the San Diego subregion (DWR 2003, p. 148). The basins that receive Delta water in the South Lahontan Hydrologic Region are the Antelope Valley Basin and the Mojave River Valley Basins (Lower, Middle, and Upper Basins). In the Colorado River Hydrologic Region, the Coachella Valley subbasins have contracts for Delta water.

Groundwater in Ventura County occurs in 32 groundwater basins, with the Santa Clara-Calleguas hydrologic unit containing the largest groundwater supply (over 28 MAF in storage; Ventura County 2009, p. 5). Groundwater recharge occurs naturally through rainfall, river/stream flow infiltration, and artificially through injection of imported water (by the Calleguas Municipal Water District) and spreading of diverted river water (by the United Water Conservation District). Groundwater basins within Ventura County are balanced, except for the Oxnard Plain pressure area, Pleasant Valley, and North Las Posas (Ventura County 2011a).

The main groundwater production basins in Los Angeles County are the West Coast and Central subbasins of the Coastal Plain of Los Angeles Basin. The West Coast subbasin is located on the southern coast of Los Angeles County and is composed of unconfined and confined aquifers. The Silverado aquifer, underlying most of the West Coast Basin, is the most productive aquifer in the subbasin, yielding almost 90 percent of the groundwater extracted annually from the subbasin (DWR 2004k, p. 2). Several fault zones paralleling the coast act as partial barriers to groundwater flow in certain areas. The basin was adjudicated in 1961, and since that time, water levels have risen about 30 feet above previous levels. The general regional groundwater flow pattern is southward and westward from the Central Coastal Plain toward the ocean (DWR 2004l, p. 2). The storage capacity of the primary water producing aquifer is estimated to be 6.5 MAF (DWR 2004l, p. 3).

The Central subbasin is located in the northeast portion of the West Coast subbasin and is the largest subbasin of the Coastal Plain of Los Angeles Groundwater Basin. The forebay portions of the subbasin are unconfined aquifers underlying the main rivers (Los Angeles and San Gabriel) and constitute major recharge areas for the subbasin. The “pressure” areas are confined aquifers composed of permeable sands and gravel separated by less permeable sandy clay and clay, and constitute the main water-bearing formations. Several faults and uplifts create some restrictions to groundwater flow in the subbasin while others run parallel to the groundwater flow and do not restrict flow. Water levels fluctuated more than approximately 25 feet between 1961 and 1977. Since 1996, fluctuations have ranged from 5 to 10 feet, and since 1999, water levels have been measured close to the historical highs. The total storage capacity of the Central subbasin is estimated to be 13.8 MAF (DWR 2004l, p. 3).

The groundwater in the San Fernando Valley Basin is mainly unconfined with some confinement in the western part of the basin and in the Sylmar and Eagle Rock areas. Well yield averages about 1,220 gpm with a maximum of about 3,240 gpm (DWR 2004m, p. 1). Several restrictive structures and faults disturb the groundwater flow in the basin. Groundwater is recharged naturally from precipitation and stream flow and from imported water and reclaimed wastewater that percolates from the Pacoima, Tujunga, and Hansen spreading grounds (DWR 2004m, p. 2). Groundwater flows generally from the edges of the basin toward the middle of the basin, then beneath the Los Angeles River Narrows into the Central subbasin of the Coastal Plain of Los Angeles Basin. Water levels have been fairly stable since the basin was adjudicated 30 year ago. Variations in water levels of 5 to 40 feet in the western part of the basin, of 40 feet in the northern and southern parts, and about 80 feet in the eastern part of the basin have been observed. Total groundwater storage capacity is estimated at 3.7 MAF (DWR 2004m, p. 2).

In the San Fernando Valley Basin, TDS range from 326 to 615 mg/L. Impairments include contamination of volatile organic compounds such as TCE, PCE, petroleum compounds, chloroform, nitrate, sulfate, and heavy metals (DWR 2004m, p. 3).

The San Gabriel Valley groundwater basin contains water-bearing materials dominated by unconsolidated to semi-consolidated alluvium deposited by streams flowing out of the San Gabriel Mountains (DWR 2004n, p. 1). Several faults surrounding this basin create partial water barriers in some areas and separate the groundwater flow from this basin from the neighboring basins. Recharge of the basin is mainly from direct percolation of precipitation and stream flow. Stream flow is a combination of runoff from the surrounding mountains, imported water conveyed in the San Gabriel River channel to spreading grounds in the Central subbasin of the Coastal Plain of Los Angeles Groundwater Basin, and treated wastewater effluent (DWR 2004n, p. 2). In general, groundwater levels follow the topography, and the flow occurs from the edges of the basin toward the center, then southwestward, and exists through the Whittier Narrows, a structural topographic low. Water levels in this basin have fluctuated more than 95 feet in the past. Since 1993, levels have fluctuated by about 30 feet. In 1999, levels were within 10 feet of the 200-year mean (DWR 2004n, p. 2). The storage capacity of this basin was estimated by DWR to be approximately 10.7 MAF. In the San Gabriel Valley Basin, TDS ranges from 90 to 4,288 mg/L and averages around 367 mg/L (DWR 2004n, p. 3). Four areas of this basin are Superfund Sites. TCE, PCE, and carbon tetrachloride contaminate the Whittier Narrows, Puente, Baldwin Park, and El Monte areas. In the Puente area, numerous cleanup operations are in effect (DWR 2004n, p. 3-4). High nitrate levels have also been measured in parts of the basin.

The main groundwater production basin in Orange County is the Coastal Plain Groundwater Basin. It underlies a coastal alluvial plain in the northwestern portion of the county. The water bearing formation is dominated by a deep structural depression that contains interbedded marine and continental sand, silt, and clay deposits (DWR 2004o, p. 1). Well yields are generally 2,000 to 3,000 gpm. The Newport-Inglewood fault zone parallels the coast and generally forms a barrier to groundwater flow. Water levels are generally lower than in 1969 and have important seasonal fluctuations (DWR 2004o, p. 2). Groundwater levels have risen since the 1990s because of several recharge programs. The Coastal Plain of Orange County groundwater basin contains a TCE plume beneath the former El Toro Marine Corps Air Station and central Irvine. The Irvine Desalter Project is designed to clean up this TCE plume. The Irvine Desalter Project pumps water from the TCE plume, which, after treatment, is used for non-drinking purposes only. Each year, the Irvine Desalter Project provides 1.3 billion gallons of clean water, which is enough to irrigate 1,300 acres of landscaping (IRWD 2011a).

In San Diego County, several smaller disconnected groundwater basins exist. The most productive groundwater basins in the County are usually located near the coast and are characterized by narrow river valleys filled with shallow sand and gravel deposits. Apart from these principal alluvial aquifers, groundwater occurs farther inland in fractured bedrock and semiconsolidated sedimentary deposits with limited yield and storage (SDCWA 2011). Groundwater production and use in the San Diego region is currently limited due to a lack of aquifer storage capacity, available recharge, and degraded water quality.

The Inland Empire area includes the groundwater subbasins in the Upper Santa Ana Valley Basin area, with the most developed being Chino and Bunker Hill in San Bernardino County. Other developed groundwater basins in the Inland Empire include Temecula Valley, San Jacinto, and Elsinore in Riverside County. The Chino subbasin is composed of alluvial material and includes several faults that act as groundwater flow barriers. Groundwater levels declined about 80 feet from historical high marks between the 1920s and 1980. By 2000, water levels had recovered about 20 feet. Groundwater in storage is estimated to be approximately 5.3 MAF (DWR 2006k, p. 2). The San Andreas and the San Jacinto fault zones create barriers to groundwater flow and raise the water table close to the surface below the Santa Ana River's bed. In general, groundwater level decreases occur in the far eastern and northwestern portions of the Bunker Hill subbasin, but levels in the rest of the subbasin are mostly stable or increasing. Groundwater in storage is estimated at approximately 5.9 MAF (DWR 2004p, p. 2). The Bunker Hill subbasin contains several contamination plumes. In Redlands, 150,000 acre-feet of groundwater are contaminated with a TCE plume mixed with PCE and dibromochloropropane (DWR 2004p, p. 2). The Chino subbasin contains a groundwater plume composed of contaminants including various volatile organic compounds, perchlorate, and heavy metals such as cadmium, nickel, chromium, and manganese in the Glen Avon area, preventing the use of private wells for drinking water supply (USEPA 2011).

In the Antelope Valley basin (South Lahontan Hydrologic Region), groundwater flows were historically from the San Gabriel Mountains in the north and the Tehachapi Mountains to the south and east toward the center of the basin near Rosamond, Rogers, and Buckhorn lakes. These dry lakes constitute groundwater discharge areas through evaporation. However, groundwater pumping because of increased demand from urbanization has altered flow patterns in areas such as Lancaster and Edwards Air Force Base (DWR 2004j, p. 2). This has caused groundwater level declines and land subsidence. An estimated 20 MAF of recoverable, useable groundwater exists in storage in the Antelope Valley Basin (Palmdale Water District 2005, p. 3-11). The average natural annual recharge for the Antelope Valley Basin was estimated at approximately 48,000 acre-feet (DWR 2004j).

The Mojave Valley (South Lahontan and Colorado River hydrologic regions) overlies several groundwater basins, many of which are within the Mojave Water Agency (MWA) boundary. In general, they are referred to as the Mojave River Groundwater Basin. An alluvial Floodplain Aquifer exists along the Mojave River, underlain by the deeper Regional Aquifer. This basin is primarily recharged by infiltration of water from the Mojave River (about 80 percent of total groundwater recharge), infiltration of storm runoff from surrounding mountains, and artificial recharge from applied irrigation water and injected recycled and imported water. Discharge occurs primarily through well pumping and evapotranspiration, as well as seepage into dry lakes and the Mojave River. It is a closed basin with very little groundwater inflow and outflow (MWA 2004, p. 3-11). Groundwater production started along the Mojave River in the early 1900s. By the mid-1950s, groundwater production was about 190,000 acre-feet, marking the beginning of the long-term overdraft trend (MWA 2004, p. 4-12). Groundwater production shifted more towards the Regional Aquifer, and wells monitored in the region show a steady decline in water levels that ranged from 50 to 100 feet over the past 50 years. Nearly all of the water supplied by MWA is from pumped groundwater. The amount of water that can be pumped is regulated by the court decision forming the basin adjudication. Groundwater quality in the MWA service area contains several contaminants such as arsenic, nitrates, iron, manganese, hexavalent chromium, TDS, total petroleum hydrocarbons, and volatile organic compounds. Some areas have concentrations of these constituents that exceed drinking water standards. The accumulation of salts in the groundwater is also an issue that occurs because the groundwater basin is a closed system and salts contained in imported reclaimed wastewater and SWP water accumulate without a natural removal process from the basin (MWA 2004, p. 4-28).

The Coachella Valley groundwater basin underlies the entire floor of the Coachella Valley and is composed of four subbasins: Indio (also called Whitewater River), Mission Creek, Desert Hot Springs, and San Gorgonio Pass. The Indio subbasin is the largest basin.

The majority of rivers in Southern California are intermittent streams that are hydraulically connected to groundwater. This connectivity results in either groundwater recharge to the aquifer or groundwater seepage into streams in areas where groundwater levels are above the channel bottom. Riverbeds are often used to facilitate the recharge of groundwater basins through the porous alluvial material that lines the natural channel bottoms.

An example of groundwater discharge to surface water can be seen in the Newport Bay Watershed, where the shallow aquifer and the surface water system are hydraulically connected. Much of the shallow aquifer flow discharges into surface channels within the watershed, as gaining conditions have been observed in several tributaries. The results of several studies confirm significant groundwater contribution to surface water. However, groundwater contributions may vary over time and season (e.g., groundwater contribution may be higher following wet conditions than during drought periods) (Orange County 2009, p. 13). This hydraulic connection is a source of selenium discharge into the surface water from the underlying shallow aquifer.

An example of surface water discharge to groundwater can be seen in the Mojave Valley, where the Floodplain Aquifer, located along the path of the Mojave River, is directly recharged by the river. The Regional Aquifer underlies and surrounds the Floodplain Aquifer in the remainder of the Mojave Valley. Prior to development in the area, groundwater flowed primarily from the Regional Aquifer to the Floodplain Aquifer. However, the groundwater flows have reversed in recent years, and the groundwater flow from the Floodplain Aquifer is currently the primary recharge component for the Regional Aquifer (MWA 2004, p. 4-12). Therefore, the Mojave River is generally a losing stream that replenishes the underlying aquifers.

3.3.5.4.4 Water Use and Infrastructure

Water supply development in Southern California has historically occurred to support population and economic growth of new communities, agriculture, and industries. When the region was first permanently settled in the 1700s, local water supplies from local rivers were adequate. Water supplies from these local sources were expanded by placing dams on rivers to divert flow and store water as well as tapping into the groundwater basins and artesian springs. These local supply sources were capable of meeting the demands from the early 1900s population boom when populations increased as much as tenfold in some areas (notably the City of Los Angeles).

After the 1900s, Southern California gradually changed from an agricultural region to an urban landscape (particularly in the coastal areas). To meet demands the region began to import water from the Owens's Valley, Colorado River, and the SWP. This imported water makes up over 50 percent of water supply in the region today (DWR 2009a).

Over half of the state's population resides in Southern California, with over 80 percent living in highly urban areas (DWR 2009a, SC-3). The primary water use between 1998 and 2005 was for urban use (over 80 percent). Urban uses are primarily located along the coastal and in the inland plains from the Simi Valley in the northwest to the border of Mexico in the south. Other uses include agricultural (about 16 percent) and environmental uses (about 3 percent). New water supply sources, such as recycled water and desalinated groundwater, and water conservation are used in the region to meet water demands as shown in Table 3-11.

Table 3-11
Water Supplies in the Southern California Region

Water Supply Source	Water Supply (Thousand Acre-Feet)							
	1998	1999	2000	2001	2002	2003	2004	2005
Surface water								
Local deliveries	292.1	286.0	211.4	217.1	152.5	162.2	142.0	585.6
Local imported deliveries	442.0	442.0	294.0	272.0	248.8	237.6	227.9	365.6
Colorado River deliveries	1,081.3	1,175.9	1,296.0	1,250.5	1,312.7	759.9	1,099.8	773.0
Other federal deliveries	4.2	1.1	0.6	0.0	53.6	0.7	0.4	42.1
SWP deliveries	687.7	735.9	1,300.1	958.7	1,536.0	1,715.1	1,839.8	1,532.6
Groundwater net withdrawal	1,223.6	1,246.1	1,372.5	1,400.0	1,356.7	1,035.3	935.9	709.3
Deep percolation of surface and groundwater	408.7	447.2	500.9	462.2	540.9	507.8	540.4	528.3
Reuse/recycle								
Reuse surface water	287.7	223.7	37.8	111.7	11.5	307.5	342.8	417.4
Recycled water	204.5	0.0	219.8	225.0	183.8	178.6	146.0	221.5
Desalination	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total supplies	4,632	4,558	5,233	4,897	5,397	4,905	5,275	5,175

Source: DWR 2009a

Urban water use in the region is concentrated along the coast and in inland valleys and is a mix of groundwater, imported water, recycled water, and surface water. In some areas, water consumption exceeds locally available supplies. This urban demand has resulted in groundwater overdraft and reliance on imported water (DWR 2009a, SC-24).

The actual source of water supply varies by area within Southern California; some areas rely on groundwater and other areas rely on imported water. In Ventura, major urban use occurs in areas located in the Santa Clarita and Simi Valley areas and on the coast near the cities of Ventura and Oxnard. Urban use is served primarily by imported water from Metropolitan along with groundwater. In Los Angeles, urban water use is supplied primarily from imported water from the SWP, Los Angeles Aqueduct, and CRA. In Orange County, water supply is met primarily with groundwater in the northern portion of the county and imported water in the southern portion of the county. In San Diego County, urban water use is primarily from imported CRA and SWP water. In the Inland Empire, water supply is a mix of local surface water, groundwater, and imported water. The Coachella Valley relies on primarily on CRA water with some local groundwater. In the high desert areas of the Antelope Valley and Mojave, water supply in urban areas is primarily from groundwater with some imported SWP water.

Agricultural areas in Southern California are primarily in the inland Valleys of Ventura County, the Inland Empire, and San Diego County (DWR 2009a, p. SC-25). Agriculture has been gradually declining in the region but still occurs in Ventura County and parts of Los Angeles, San Diego, and Orange counties and the Inland Empire. Agriculture is the primary use in Ventura County (Santa Clara region).

Because of its climate and location, Southern California continues to search for reliable water supplies to support its population. Existing water supplies have been fully used but are at risk because of the interdependence of supplies and the reliance on imported water. Imported water reductions and drought conditions are challenging water supply managers in the region to identify new mechanisms to ensure supply.

Imported Water

Water was first imported via the Los Angeles Owens Valley Aqueduct in 1913. This aqueduct was extended to reach Mono Lake in 1941. A second Los Angeles Aqueduct was constructed to perfect water rights in the Owens Valley and at Mono Lake in the 1960s. Imported water comprises over half of water supplied in Southern California, but in the 1960s, these imports faced limitations from legal and environmental decisions.

The Los Angeles Aqueduct moves water from the Owens's Valley to the city of Los Angeles via a 233-mile pipeline. The aqueduct has a capacity of 485 cubic feet per second. The second Los Angeles Aqueduct was completed in 1970 with a capacity of 290 cfs. The second aqueduct begins at the Haiwee Reservoir and conveys water 137 mile to the Cascades, where the water enters the Los Angeles area (Los Angeles Department of Water and Power 2011).

Southern California imports water supplies from the Colorado River via the Colorado River Aqueduct and the All-American Canal systems. In 1922, the Colorado River Compact was signed to allocate water between the seven Colorado River Basin states. In 1928, Congress adopted the Boulder Canyon Project Act to construct Hoover Dam and the All-American Canal, which would deliver up to 4.4 MAF per year of water to California. The California Seven Party Agreement of 1931 allocated the Colorado River water supply within California, including the provision of water supplies to Imperial Irrigation District and San Diego. A Supreme Court Decision (Arizona v. California) in 1963 cut water supplies from the Colorado River in half, reducing imported water supplies to California. This decision limited California rights on the Colorado to 4.4 MAF plus half the surplus water. The Quantification Settlement Agreement was reached in 2003 and quantifies the priority of rights on the lower Colorado River and establishes a transfer of water conserved from lining the All-American Canal from Imperial ID to San Diego County Water Authority. Water supply reliability continues to be a concern in the Colorado River Basin as water use is increasing while Colorado River flows are generally decreasing (on a 10-year average).

The CRA moves water from the intake at Parker Dam/Lake Havasu 242 miles to Lake Mathews. The CRA was initially constructed in 1941 but was expanded in the 1960s so that it has a delivery capacity of 1.3 MAF of water annually. The CRA system consists of 5 pumping plants, 16 hydroelectric plants, 9 reservoirs (over 1 MAF of total capacity), 5 water treatment plants, and over 800 miles of transmission lines to move water to Metropolitan member agencies (Metropolitan 2011a, p.1). The CRA supplies Metropolitan member agencies.

The All-American Canal supplies water to the Coachella Valley Water District and the Imperial Irrigation District. The Canal system consists of the Imperial Diversion Dam and Desilting Works, the 80-mile-long All-American Canal, the 123-mile-long Coachella Canal, and appurtenant structures including a number of drop structures. The system has the capacity, through water diversions from the Colorado River at Imperial Dam, to provide irrigation water for nearly 600,000 acres of land in the Imperial and Coachella valleys (Reclamation 2010a, p. 1).

Metropolitan is the largest of the SWP contractors and receives water from the California Aqueduct at Castaic Lake in Los Angeles County, Devil Canyon Afterbay in San Bernardino County, and Box Springs Turnout and Lake Perris in Riverside County.

Water deliveries from the SWP vary based on climatic conditions, Sierra Nevada snowpack, and contractor demands. Historically, SWP demands for water have been met except in drought years. However, in recent years, SWP imports have been impacted by drought conditions and environmental restrictions put in place on the Delta that reduce export pumping at the Banks Pumping Plant. Water supplies from the SWP have been reduced due to biological opinions made by the Fish and Wildlife Service to protect endangered species such as the Delta smelt. These changes have resulted in a 30 percent loss of supply for the average year from the SWP, causing Metropolitan to draw upon reserve supplies in 7 out of 10 years instead of replenishing them (Metropolitan 2010, p. 1-15).

Environmental Water Use

Environmental water use for in-stream flows, habitat, and improved water quality is approximately 3 percent of total water use in southern California. Environmental water use is low due to the modifications made to most of the streams/creeks/rivers in Southern California. Natural systems in southern California have been modified to provide for water supply and flood control including lining of riverbeds with concrete and construction of dams in upstream areas of watersheds. One Sespe River section has been designated by the USFWS as a Wild and Scenic River. The 31-mile section of the Sespe River serves as a rainbow trout fishery and the critical habitat for the endangered California condor (DWR 2009a, SC-20).

Because of the hydrologic modifications that have occurred in southern California, there has been an effort made in the last 20 years to reuse wastewater and recycled water to improve habitat and provide flows for in-stream uses. The most significant effort has been in the construction or restoration of wetlands, estuaries, and lagoons. Constructed wetlands have been developed in Los Angeles region (Sepulveda basin, Dominguez Gap, and DeForest Park), in the Santa Ana region (at Hemet/San Jacinto, Prado Basin, and Inland Empire Utilities Agency headquarters), in San Diego region (San Joaquin Marsh and Santee Lakes).

Groundwater Use

Groundwater is the second largest source of supply used in southern California. In the Metropolitan service area, groundwater supplies meet approximately 40 percent of the total annual water demand (Metropolitan 2007). Groundwater use in the region is greater in drought years and less in normal and wet years.

Groundwater is the largest source of water supply in Ventura County where it provides about 67 percent of the locally used water in the County (Ventura County 2011b). Groundwater use in the Antelope Valley is currently estimated to be approximately 90,000 acre-feet per year, which exceeds estimated recharge by approximately 40,000 acre-feet per year (Palmdale Water District 2005).

The Water Replenishment District of Southern California (WRD) manages groundwater in the Central and West Coast subbasins of the Coastal Plain of Los Angeles groundwater basin. The total adjudicated groundwater amounts to approximately 282,000 acre-feet per year. Currently about 250,000 acre-feet of water are pumped by WRD every year to meet the users’ demands (WRD 2010).

The Coachella Valley (Colorado River Hydrologic Region) relies on a combination of local groundwater, Colorado River water, SWP water, surface water, and recycled water to meet water demands. Coachella

Valley Water District (CVWD) supplies all of its domestic water with groundwater and annual sales are nearly 125,000 acre-feet (CVWD 2011).

Development of groundwater in Southern California may be limited because of availability of brine disposal systems, treatment costs, and declining groundwater elevations. For example, the Santa Ana Regional Interceptor is experiencing capacity limitations that may impede future brackish desalination (Reclamation 2009a, p. 54). Twenty-eight groundwater desalter and ion exchange facilities are either planned or in operation to reclaim brackish (TDS > 1,000 mg/L) or poor quality groundwater. These facilities as well as several industrial facilities and other groundwater remediation sites use brine pipelines or sewers for waste disposal. Table 3-12 summarizes the location and production capacities of these desalting facilities.

Table 3-12
Amount of Existing Groundwater Desalting in Southern California

	Planning Year 2010		
Local Area	**Capacity (mgd)**	**Maximum Daily Flow (mgd)**	**Average Daily Flow (mgd)**
Ventura County	11.50	11.50	11.50
Los Angeles County	36.14	36.14	31.14
Inland Empire	30.96	30.96	30.20
Orange County	20.43	19.43	19.43
San Diego County	21.20	21.20	19.95
Total	120.23	119.23	112.22

Source: Reclamation 2009a

Several groundwater basins and subbasins have been adjudicated in court in Southern California. Table 3-13 summarizes the adjudicated subbasins.

Table 3-13
Adjudicated Groundwater Basins in the Southern California

Basin Name	Date of Final Court Decision	County	Hydrologic Region
Central Basin	1965	Los Angeles	South Coast
Chino Basin	1978	San Bernardino	South Coast
Cucamonga Basin	1978	San Bernardino	South Coast
Main San Gabriel Basin: Puente Narrows	1973	Los Angeles	South Coast
Mojave Basin Area	1996	San Bernardino	South Lahontan
Puente Basin	1985	Los Angeles	South Coast
Raymond Basin	1944	Los Angeles	South Coast
Santa Margarita River Watershed	1966	San Diego	South Coast
Santa Paula Basin	1996	Ventura	South Coast
Six Basins	1998	Los Angeles	South Coast
Tehachapi Basin	1973	Kern	South Lahontan

Table 3-13
Adjudicated Groundwater Basins in the Southern California

Basin Name	Date of Final Court Decision	County	Hydrologic Region
Upper Los Angeles River Area (including San Fernando Basin)	1979	Los Angeles	South Coast
Warren Valley Basin	1977	San Bernardino	Colorado River
West Coast Basin	1961	Los Angeles	South Coast
Western San Bernardino	1969	San Bernardino	South Coast

Sources: DWR 2003, DWR 2011c

An adjudication process is currently underway for the Antelope Valley groundwater basin located in Kern and Los Angeles Counties.

Groundwater Recharge, Conjunctive Use, and Groundwater Banking

Currently, over 758,000 acre-feet per year of groundwater is recharged; however, more than 3.2 MAF of storage is available for recharge (Metropolitan 2007). Recharge water sources include stormwater, runoff, recycled, and imported water. Over 1,000 acres of basins as well as 36 groundwater injection wells are used to recharge groundwater basins in Southern California to halt the decline of groundwater levels and the intrusion of seawater into aquifers that provide drinking water supplies.

The Calleguas Municipal Water District (CMWD), in partnership with Metropolitan, is developing and operating the Las Posas Basin Aquifer Recharge and Recovery project. CMWD receives drinking water supply from the SWP through Metropolitan, and stores surplus water in the Las Posas Valley groundwater basin, near the City of Moorpark. It is estimated that the Las Posas Basin can store approximately 300,000 acre-feet of imported water. The current Aquifer Recharge and Recovery system includes 18 wells, each with an approximate extraction capacity of 4 cfs and an injection capacity of 3 cfs (CMWD 2011).

The LACDPW operates several spreading grounds as part of the San Gabriel River and Montebello Forebay Water Conservation System. Current operations at these recharge facilities conserve an average of approximately 150,000 acre-feet of local, imported, and reclaimed water annually. The Rio Hondo Coastal Basin Spreading Grounds cover about 570 acres and receive diverted water from the Rio Hondo Channel by three large radial gates in addition to stormwater capture. The San Gabriel River Coastal Basin Spreading Grounds total 128 acres in size. The lower San Gabriel River, from Whittier Narrows Dam to Florence Avenue, also allows spreading by percolation through its unlined bottom (LACDPW 2011).

The WRD operates a water replenishment system that incorporates water from two different sources: recycled water from various regional treatment facilities, and imported water from Metropolitan member agencies, and other cities and water districts in the region. The recycled water is used for groundwater recharge at the spreading grounds and at the seawater barrier wells. WRD must blend recycled water with other water sources to meet the SWRCB Groundwater recharge requirements. This blended water is either imported water from the SWP and the Colorado River or untreated surface water. Typically, surface water is used at surface spreading grounds and the imported water is used in seawater intrusion wells (WRD 2010, p. IV-1). Three seawater intrusion projects are operated in the Coastal Plain of Los Angeles Basin: the West Coast Basin Barrier Project, the Dominguez Gap Barrier Project, and the Alamitos Barrier Project (WRD 2007). These barriers were put into operation to counteract the seawater intrusion that began as early as the 1940s.

Orange County Water District manages an extensive groundwater recharge program in the Coastal Plain of Orange County Basin (Orange County Water District 2011). Water is supplied to these basins by either diverting flows from the Santa Ana River via inflatable rubber dams or by conveying purified wastewater and stormwater from Oceano CSD. The Groundwater Replenishment System (GWRS) supplies 35 million gallons daily of advanced treated wastewater via a 13-mile pipeline. The water is used to recharge the Kraemer and Miller basins located in Anaheim. In addition to recharging the aquifer, the GWRS pumps approximately 35 million gallons of treated water daily into 23 injection wells along the coast near Huntington Beach and Fountain Valley. These wells are used to create a seawater intrusion barrier, which protects groundwater supplies that were at risk due to overpumping (GWRS 2011).

Water districts in Southern California have entered into agreements with water banks in Kern and Tulare counties in the Tulare groundwater basins to store water as emergency supplies. The SWP water stored in these groundwater banks outside Southern California is then transferred to the receiving water districts. For example, Metropolitan is a groundwater banking partner of the Semitropic WSD.

Groundwater banking also occurs locally in Southern California. For example, the Irvine Ranch Water District (IRWD) has entered into a 30-year water banking partnership with the Rosedale-Rio Bravo Water Storage District in Kern County. IRWD has purchased land overlying the Kern County groundwater basin in the Rosedale Rio Bravo Water Storage District. Both districts collaborated to build 502 acres of recharge ponds to allow available surface to percolate into the groundwater basin for later use (IRWD 2011b). Local groundwater banking occurs primarily for storage of Colorado River water, which is conveyed via the Colorado River Aqueduct to the underground storage basins.

As part of the Coachella Valley Groundwater Storage Program, Metropolitan supplies the Desert Water Agency and Coachella Valley Water District with Colorado River water in advance of the time they are entitled to receive water under the exchange contracts. This water is currently stored at the Whitewater recharge area, which provides water to the upper Coachella Valley groundwater basin underlying the Desert Water Agency service area. The maximum annual withdrawal rate is currently 61,200 acre-feet. A feasibility study of the conjunctive use program that would store water in the lower basin has been authorized (Metropolitan 2011b).

Antelope Valley Water Bank (AVWB) is a groundwater banking partner of Semitropic WSD. As discussed in the Tulare Lake Section, these two agencies formed the Semitropic-Rosamond WBA to increase overall water storage and recovery capacity. The total storage capacity of the AVWB is estimated at 500,000 acre-feet at full built-out with an annual recharge and recovery of 100,000 acre-feet (Reclamation 2010b, p. 1). Water for recharge and storage in the AVWB will be delivered via the East Branch of the California Aqueduct. The first phase of construction occurred in 2008 and the first phase of recovery facilities are scheduled to come online by February 2011, with capacity ramping up from 25,000 AF/yr to 100,000 AF/yr as needed there-after.

MWA has developed groundwater banking projects to store SWP water for future use. The Oro Grande Recharge Project is composed of four percolation ponds at the Oro Grande Wash, which receive SWP water. This program has provided valuable information that will be used for design and implementation of a full-scale facility (MWA 2011). In addition, MWA is developing a new Regional Recharge and Recovery Project (also known as R3) for managing water resources and supply. This project will recharge local aquifers with imported SWP water along the Mojave River for underground storage. Five recovery wells will subsequently pump the stored water and convey it to local water providers for further distribution to customers. The R3 project will include new pipelines that link to existing infrastructure (R-Cubed 2011).

Water Recycling and Water Conservation

Recycled water has been used since 1906 in Oxnard and 1932 in the city of Pomona for irrigation. Large-scale water reuse in the region began in the early 1960s with artificial recharge of groundwater at Whittier

Narrows and urban irrigation and industrial use within Irvine Ranch Water District's service area. In Southern California there are over 129 wastewater plants that have a treatment capacity over 1 mgd (Reclamation 2006b, Attachment C). Of these, 104 plants currently produce over 400,000 acre-feet per year of recycled water. This is over 35 percent of the total wastewater produced in Southern California. Recycled water in Southern California is used for groundwater recharge (25 percent), seawater intrusion (19 percent), landscape irrigation (21 percent), industrial (14 percent), miscellaneous uses (9 percent), environmental (7 percent), and agricultural (5 percent) uses. To date a majority of recycled water projects have occurred by retrofitting existing facilities, which is expensive due to the complex nature of the projects, conflicts with existing infrastructure, and disruption of the public. For new developments, dual plumbing of homes and facilities is mandated in the majority of Southern California and makes implementing recycled water use more cost effective.

Another area of emerging water reclamation is agricultural drain water. Reclamation of these flows is planned by CVWD and Metropolitan in the San Joaquin Valley. The CVWD plans to reclaim up to 11,000 acre-feet per year of agricultural drain water. This water would be treated at a 10-mgd desalination plant to match the water quality in the CVWD canal (Colorado River water) for irrigation users.

In the Mojave Valley, approximately 9.8 mgd is treated at the Victor Valley Wastewater Reclamation Authority's facility. The reclaimed water is discharged into the Mojave River channel or percolation ponds to recharge the surficial aquifer (MWA 2004, p. 3-24). Wastewater is also imported from the Lake Arrowhead CSD, Big Bear Area Regional Wastewater Agency, and Crestline Sanitation District. Imported wastewater is discharged into the Mojave River and other areas in the Valley (MWA 2004, p. 4-11).

Desalinated Seawater

Desalinated seawater is currently being proposed in Los Angeles, Orange, and San Diego counties. To date, five desalination projects have been identified in the area and three others have been proposed as seen in Table 3-14. Currently, only the Carlsbad Desalination Plant has progressed to the construction phase. Obstacles to large-scale implementation of desalination include, land, treatment, outfall system and operational costs, as well as environmental review and permitting process (over 20 local, State, and federal agencies are involved in the process).

Table 3-14
Planned and Proposed Seawater Desalination Projects in Southern California

Project	Agency	Project Size (acre-feet per year)	Project Status
Camp Pendleton Seawater Desalination Project	San Diego County Water Authority	56,000 to 168,000	Planning
Carlsbad Seawater Desalination Project	San Diego County Water Authority	56,000	Construction
Huntington Beach Seawater Desalination Project	Municipal Water District of Orange County	56,000	Certified Final EIR; CDP/permits still pending
Long Beach Seawater Desalination Project	Long Beach	10,000	Pilot Study[a]
Los Angeles Seawater Desalination Project	Los Angeles Department of Water and Power	28,000	On hold
Rosarito Beach Seawater Desalination Feasibility Study[b]	San Diego County Water Authority	28,000 to 56,000	Feasibility study
South Orange Coastal Ocean Desalination Project	Municipal Water District of Orange County	16,000-28,000	Pilot Study[a]

Table 3-14
Planned and Proposed Seawater Desalination Projects in Southern California

Project	Agency	Project Size (acre-feet per year)	Project Status
West Basin Seawater Desalination Project	West Basin Municipal Water District	20,000	Pilot Study[a]
Total		270,000 to 422,000	

Source: Metropolitan 2009
[a] Full-scale feasibility and design studies are underway at these locations.
[b] Includes water for service outside of Southern California area.

Water Transfers and Exchanges

There are a number of agreements that allow for water transfers or wheeling of water through systems in Southern California as seen in Table 3-15. Many public and private water providers use these agreements to increase water supply reliability and obtain access to water supply sources. For example, Golden State Water Company has emergency connections with a number of public water companies in the Los Angeles area that enables the movement of water into different areas of a system during emergencies.

Table 3-15
Southern California Water Supply Transfers and Exchange Agreements

Arvin-Edison Water Management Program	Storage of up to 250,000 acre-feet of water in Arvin-Edison groundwater basin during years when SWP is available for extraction during dryer periods.
Central Valley/SWP Storage and Transfer and Program	Metropolitan has had success in purchasing options from Sacramento Valley irrigators of 145 thousand acre-feet (TAF) in 2003, 113 TAF from Sacramento Valley irrigators (as part of State Water Contractors Agreement for 145 TAF of options) in 2005, 40 TAF in 2008, and 34 TAF in 2009. Also, Metropolitan has been successful in purchasing water for storage in the Central Valley. In 2009, 300 TAF was purchased and stored as part of this program.
Chuckwalla Groundwater Storage Program	Colorado River Aqueduct water would be stored in the Upper Chuckwalla Groundwater Basin for recovery during droughts. A maximum of 150,000 acre-feet of storage is available from this project. This project is currently on-hold due to drought conditions on the Colorado River.
Castaic Lake Water Agency / Buena Vista and Rosedale - Rio Bravo Water Storage Districts Agreement	The Castaic Lake Water Agency has a developed a long-term water agreement for 11,000 acre-feet per year of water from the Buena Vista and Rosedale - Rio Bravo Water Storage Districts. This agreement allows exchange or recharge of Kern River for SWP water.
Desert Water Agency/Coachella Water District SWP Table A Water Transfer	This agreement transfers cost of water costs to Desert Water Agency to reduce Metropolitan's fixed water costs.
Hayfield Groundwater Storage Program	Colorado River Aqueduct water is stored in the Hayfield Groundwater Basin, which is located in east of Palm Springs in Riverside County, for future extraction. Currently 70,000 acre-feet is in storage but 400,000 acre-feet of storage is planned.
Kern-Delta Metropolitan Water Management Program	Storage of up to 250,000 acre-feet of SWP water in Kern-Delta's groundwater basin with a right to retrieve up to 50,000 acre-feet per year.
Lower Coachella Valley Groundwater Storage Program	Advance delivery and storage of CRA water for an exchange agreement with CVWD and Desert Water Agency for SWP water. Maximum storage is 500,000 acre-feet. This project is currently on-hold due to drought conditions on the Colorado River.
Mojave/Metropolitan Demonstration Water	Exchange of SWP water on the basis of 1 acre-foot of return water for each acre-foot

Table 3-15
Southern California Water Supply Transfers and Exchange Agreements

Exchange Program	of water previously delivered to Mojave Water Authority.
Quantification Settlement Agreement transfers	Transfer of water from Imperial Irrigation District (IID) to San Diego County Water Authority (SDCWA) based on water conservation measures including lining of the All-American and Coachella Canals (77,000 acre-feet per year) and 16,000 acre-feet per year from other canal lining. The Quantification Settlement Agreement also includes other water transfers of water including 10,000 acre-feet per year (ramping up to 200,000 acre-feet per year for up to 75 years) from IID to SDCWA, 110,000 acre-feet per year from IID to Metropolitan, 103,000 acre-feet per year from IID to CVWD, and between 25,000 and 111,000 acre-feet annually from the Palo Verde Irrigation District to Metropolitan.
Semitropic Water Banking and Exchange Program	Storage of SWP in Semitropic WSD’s groundwater basin during wet years, which can be withdrawn during dry years for supply. Maximum storage capacity is 350,000 acre-feet. The Castaic Lake Water Agency also has over 50,000 acre-feet of water banked in this system, which is available for use until 2013.
Tulare Basin Storage District Groundwater Replenishment Project	The CVWD has purchased 9,900 acre-feet per year of SWP water from the Tulare Lake Basin Water Storage District for groundwater replenishment. The CVWD also has purchased 16,000 acre-feet per year of SWP water from the Berrenda Mesa Water District.
Yuba Dry Year Water Purchase Program	Metropolitan entered into an agreement with Yuba County Water Agency allows purchase of dry year water through 2035.

Source: Metropolitan 2010

3.4 Impacts Analysis of Project and Alternatives

3.4.1 Assessment Methods

The Proposed Project (Delta Plan) and alternatives would not directly result in construction or operation of projects or facilities, and therefore would result in no direct impacts on water resources.

The Proposed Project and alternatives could ultimately result in or encourage implementation of actions or development of projects, such as facilities or infrastructure, as described in Section 2A, Proposed Project and Alternatives. The precise magnitude and extent of project-specific impacts on water resources would depend on the type of action or project being evaluated, its specific location, its total size, and a variety of project- and site-specific factors that are undefined at the time of preparation of this program-level study. Project-specific water resource impacts would be addressed in project-specific environmental studies conducted by the lead agency at the time the projects are proposed for implementation.

This EIR proposes mitigation measures for impacts on water resources. The ability of these measures to reduce impacts to less-than-significant levels also depends upon project-specific environmental studies; enforceability of these measures depends upon whether the project being proposed is a covered action. This is discussed in more detail in Section 15.5.3.6 and in Section 2B, Introduction to Resource Sections.

This program-level document qualitatively assesses the potential impacts on water resources resulting from implementation of the Proposed Project and alternatives. Water resources impacts from implementation of the alternatives were evaluated in terms of how project components might cause adverse environmental impacts. Because project-level construction disturbance details are not available for the project components analyzed, potential impacts were not evaluated on a site-specific basis.

3.4.2 Thresholds of Significance

Based on Appendix G of the California Environmental Quality Act (CEQA) Guidelines and the particular impact of this project, an impact related to water resources is considered significant if the proposed project would:

- Violate any water quality standards or waste discharge requirements or otherwise substantially degrade water quality;
- Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted), or
- Substantially change water supply availability to water users located outside of the Delta that use Delta water.

The following discussion of environmental impacts are limited to those potential impacts that could result in some level of potentially significant environmental change, as defined by CEQA and as appropriate for this analysis. As individual projects are proposed, these individual projects would need to be evaluated in site-specific environmental documents prepared by the lead agencies.

3.4.3 Proposed Project

3.4.3.1 Reliable Water Supply

As described in Section 2A Proposed Project and Alternatives, and Section 2B, Introduction to Resource Sections, the Delta Plan does not direct the construction of specific projects, nor would projects be implemented under the direct authority of the Delta Stewardship Council. However, the Delta Plan seeks to improve water supply reliability by encouraging various actions, which if taken could lead to completion, construction and/or operation of projects that could provide a more reliable water supply. Such projects and their features could include the following:

- Surface water projects (water intakes, treatment and conveyance facilities, reservoirs, hydroelectric facilities)
- Groundwater projects (wells, wellhead treatment, conveyance facilities)
- Ocean desalination projects (water intakes, brine outfalls, treatment and conveyance facilities)
- Recycled wastewater and stormwater projects (treatment and conveyance facilities)
- Water transfers
- Water use efficiency and conservation program implementation

The number and location of all potential projects that would be implemented is not known at this time. However, the Proposed Project specifically names the DWR Surface Water Storage Investigation, which includes the North-of-the-Delta Offstream Storage Investigation (aka Sites Reservoir), Los Vaqueros Reservoir Project (Phase 2), and the Upper San Joaquin River Basin Storage Investigation Plan (aka Temperance Flat Reservoir). It also encourages the update of Bulletin 118 that could lead to improvements in groundwater management and development of related facilities

3.4.3.1.1 Impact 3-1a: Violate Any Water Quality Standards or Waste Discharge Requirements or Substantially Degrade Water Quality

Construction Effects

Construction-related activities at construction sites for surface water and groundwater storage facilities, including those under consideration in the DWR Surface Water Storage Investigation, could require movement of earth and the use of heavy equipment. These types of construction activities could cause temporary sediment disturbance and re-suspension, which may cause siltation, as well as enhanced bioavailability of sediment-associated pollutants (e.g., trace metals, heavy metals, pesticides) in affected waterways. Ground disturbance at these construction sites could increase the potential for runoff of construction-related chemicals (such as equipment oils) and materials to waterways.

The EIR prepared for the Los Vaqueros Reservoir Expansion Project (Reclamation and CCWD 2009), a project considered under the Surface Water Storage Investigation, described the impacts associated with that project and also provides information on water quality impacts and mitigation that might result from similar reservoir construction projects. This EIR reported that in-channel construction activities would impact water quality due to localized suspended sediment and turbidity. However, these impacts would be less than significant after standard construction BMPs for mitigation measures, such as the development of a Storm Water Pollutant Prevention Plan (SWPPP) that specifies temporary control measures (e.g., fiber rolls, straw bales, detention basins), the control of fueling and vehicle staging, and the use of vegetated buffers (Reclamation and CCWD 2009).

The EIR for another reservoir construction project, the Calaveras Dam Replacement Project (SFPUC 2011) provides a further example of the types of water quality impacts associated with surface water storage projects. For this project, the SFPUC found that water quality impacts associated with project construction would be less than significant or less than significant with mitigation. The mitigation measures for the Calaveras Dam Replacement Project included completion of a SWPPP consistent with the requirements of the SWRCB General Permit for Storm Water Discharges Associated with Construction Activity to be approved by the San Francisco Bay RWQCB. The SWPPP is to include methods to preserve vegetation, capture water generated at the construction site and treat the water prior to discharge from the site, spill prevention, and an inspection and maintenance program with appropriate monitoring tasks and reporting to the RWQCB.

Construction activities located adjacent to waterways, such as pumping plants, could require the use of heavy equipment within the channel. These types of construction activities could cause temporary sediment disturbance and re-suspension, which may cause enhanced bioavailability of sediment-associated pollutants (trace metals, heavy metals, pesticides, etc.) in affected waterways. Construction or repair of in-channel structures, such as diversions, barriers, or water intakes, would increase the potential for affecting water quality by causing temporary disturbance of streambed sediments and the possible re-suspension of sediment-associated pollutants (trace metals, heavy metals, pesticides, etc.) in the affected waterways. Construction of conveyance facilities (canals, pipelines, tunnels, or siphons) could require the use of heavy equipment and ground disturbance along the conveyance route. Similar water quality impacts as described for the construction of facilities adjacent to waterways would be expected in areas where the alignments transected waterways.

The Davis-Woodland Water Supply Project EIR (City of Davis and City of Woodland 2007), a project that included a diversion/intake structure, water conveyance pipeline, and water treatment facility, was reviewed as an example of the types of water quality impacts that could result from the construction of water supply facilities. The lead agency found that the project could violate water quality standards or waste discharge requirements, but that the impacts would be less than significant with the implementation of a SWPPP and standard mitigation measures (as described above) for construction of projects immediately adjacent to waterways.

Effects of Project Operation

Operations of new water supply facilities whether in-stream, such as storage reservoirs, or located near a waterway, such as pipelines, tunnels, canals, pumping plants, water intakes or diversions, may create long-term changes in local mixtures of source waters within channels. Operations of intakes or diversions may create long-term changes in the balance of sedimentation and scour within channels, which may cause siltation and increased bioavailability of certain pollutants (e.g., mercury, selenium). Enhanced scour may re-suspend fine sediments and contaminants associated with sediments, both of which could cause violations of water quality standards. Areas of enhanced deposition may require dredging to allow navigation and/or to remove potentially contaminated sediments. Areas of enhanced deposition of soft sediments may also create areas of increased bioavailability of mercury, selenium, or other contaminants to fish and wildlife. However, the potential for these facilities to generate water quality impacts is generally lower during operation than it is during construction.

The operation of new reservoirs could potentially influence the temperature and the chemical composition of the receiving water downstream of the new dam. However, reservoirs will likely be operated in a manner to meet water quality and temperature objectives established by the Regional Water Quality Control Board for the downstream waters. The Los Vaqueros Reservoir Expansion Project EIR was reviewed as an example of an EIR that assesses the effects on water quality from a reservoir operation. The lead agency found that the project would not result in significant adverse changes in Delta water quality that could cause the violation of a water quality standard (Reclamation and CCWD 2009).

Water transfers to facilitate water supply reliability could influence water quality by producing temporary changes in flow that could affect the concentrations of regulated water quality constituents, including water temperature within the Delta watershed tributaries. The Lower Yuba River Accord EIR (Reclamation et al. 2007) was reviewed as an example of an EIR that assessed the effects of water management, including water transfers. In this document, the lead agency found that changes in flows caused by the project, as available through hydrologic modeling results, had the potential to influence salinity and water temperature in some parts of the Delta, but that those impacts would be less than significant following implementation of mitigation measures by the water purchasers to purchase additional transfer water that would be released from upstream reservoirs during drier periods to mitigate water quality impacts.

The operation of ocean desalination plants result in the release of concentrated brine, which could affect ocean water quality. However, SWRCB and/or RWQCB discharge requirements would apply to such facilities. In addition, several State agencies have permit and approval authority over implementation of desalination, including the Coastal Commission, the State Lands Commission, the Department of Fish and Game, the Public Utilities Commission, the Department of Health Services, and the California Department of Transportation. It may be assumed that desalination plants would comply with these mandates. Therefore, the operation of desalination plants is not expected to cause adverse effects on water quality.

Project-level impacts would be addressed in future site-specific environmental analysis conducted at the time such projects are proposed by lead agencies. However, because named water supply reliability projects and projects encouraged by the Delta Plan could result in the potential violation of water quality standards due to construction activities and operation of facilities that would disturb the water chemistry and liberate certain pollutants in waterways, the potential impacts are considered **significant**.

3.4.3.1.2 Impact 3-2a: Substantially Deplete Groundwater Supplies or Interfere Substantially with Groundwater Recharge

Construction Effects

Activities related to the construction of surface water storage facilities, such as the ones considered under the DWR Surface Water Storage Investigation, could include temporary de-watering to facilitate construction of necessary infrastructure. The construction of water intake facilities would include development of pumping plants, fish screens, and other associated conveyance infrastructure. Construction of this type of infrastructure may include temporary de-watering activities to facilitate construction of the necessary infrastructure. Similarly, the construction of pumping plants, pipelines, tunnels, regulating reservoirs, and canals in areas of shallow groundwater may include temporary de-watering activities to facilitate construction of the necessary infrastructure. These activities could result in a temporary reduction in groundwater levels, which would be expected to return to pre-construction levels quickly after termination of de-watering activities.

Effects of Project Operation

If surface water storage facilities are in hydraulic connection with the underlying groundwater aquifer system, some increase in local groundwater levels in the vicinity of the facility may occur during long-term operation. If the additional surface water supply provided by the storage facility is used as an alternative to groundwater production, or to supply artificial aquifer recharge programs, such as might be the case in areas outside of the Delta, then groundwater levels in the source aquifer could be expected to rise due to associated decreases in groundwater production or increases in groundwater recharge. This would provide a benefit to groundwater levels.

One of the ongoing projects that illustrates the construction of a surface water storage facility is the Los Vaqueros Reservoir Expansion Project. This project includes construction of dam modifications that would be typical of local and regional surface water storage projects. The EIR evaluated operations of increased water storage, a new Delta intake structure, and conveyance facilities. According to the findings in the Draft EIS/EIR, the construction of the project facilities would not require long-term extraction of groundwater supplies or significantly interfere with groundwater recharge. In addition, any localized drawdown due to dewatering operations would be minimal and temporary. There are no wells located in the immediate vicinity of the reservoir that could be affected during reservoir dewatering. Therefore, “construction and operation of the project alternatives would not deplete local groundwater supplies or interfere with groundwater recharge.” Consequently, Reclamation and CCWD concluded that no mitigation was required (Reclamation and CCWD 2009).

Long-term operation of a groundwater storage facility encouraged by the Delta Plan would by definition result in significant fluctuations in local groundwater levels. Rising groundwater levels would occur as artificial recharge is induced into the aquifer system, followed by groundwater level declines during subsequent removal of groundwater from storage. There is currently no statewide groundwater management legislation that would regulate this type of facility. However, any operating groundwater storage facility would be subject to local groundwater management regulations (basin adjudications, county ordinances, or local groundwater management plans), as described in Appendix D.

Groundwater storage facilities would be encouraged to be constructed in areas such as the San Joaquin watershed, the Tulare Lake area, and certain areas in Southern California, where groundwater banking is needed to sustain long-term water supplies or provide emergency water supplies during drought conditions (WR P1). An example of an ongoing project for a groundwater storage program is the Western Municipal Water District (WMWD) Riverside-Corona Feeder Project. This project includes construction of conveyance and groundwater recharge facilities that would be typical of local and regional groundwater projects used by communities in Southern California during drought and emergency periods. The project’s EIR indicates that impacts on groundwater levels could potentially be significant. The project included mitigation measures using a groundwater model, monitoring, and adaptive management. For example, if the models suggest that the replenishment and pumping regime of the proposed project operation would result in a water level reduction of greater than 10 feet, the project operation will be modified to reduce impacts to less than significant levels (WMWD and Reclamation 2011). The WMWD determined that this type of mitigation measure would reduce the impact to less than significant after the following mitigation measures are implemented (WMWD and Reclamation 2011).

Local surface water and groundwater projects could include canals to convey water to local surface water storage, groundwater storage, or water treatment plants. The long-term operation of canal segments used for conveyance as part of a local or regional water management project may result in leakage of conveyance water into the underlying aquifer in areas where groundwater levels lie below the stage of the canal. The operation of unlined canals would result in greater leakage quantities, but even lined canals lose some water to the subsurface. This increased quantity of recharge to the aquifer system would result in an increase in groundwater levels in the vicinity of the canal, which constitutes a benefit to local groundwater resources.

The influence of water transfers on groundwater levels would depend on the type of water transfer being conducted. For a groundwater substitution water transfer, the groundwater pumping quantities would be increased in the vicinity of the seller to provide additional water supply to replace the transferred water. This increased groundwater production would result in decreased groundwater levels. The duration of the reduction in groundwater levels would be dependent on the frequency of transfer operations (such as multiple 1-year transfers or infrequent transfers) and the volume of groundwater extracted. These types of activities and related impacts are most likely to occur in the Sacramento Valley, where water supplies are more abundant and water can be transferred to other regions south of the Delta. Other types of water transfers that do not rely on groundwater to replace the transferred water would not affect groundwater levels in the vicinity of the seller, but the increased recharge due to application of the transferred water may result in an increase in groundwater levels at the point of application, again providing a benefit. One of the ongoing projects representing water transfer is the Proposed Lower Yuba River Accord (Reclamation et al. 2007). This project is typical of a water transfer project and includes a groundwater substitution water transfer from the Sacramento Valley (Yuba County) to south of the Delta. The EIR for this project states that the anticipated groundwater pumping under the various alternatives would be within historical ranges. Because groundwater storage capacity and groundwater levels in the Yuba Basin are well above historical lows and no-long term impacts occurred from past groundwater substitution transfers, Reclamation, DWR, and Yuba County Water Agency determined that the ranges of pumping under these alternatives would not result in long-term significant or unmitigated impacts to groundwater levels and storage. Thus, impacts on groundwater levels and storage would be less than significant. The implementation of a water use efficiency program could act to reduce the quantity of groundwater recharge that occurs due to deep percolation of applied water for landscape irrigation or other uses. This effect would likely have a very minor influence on groundwater levels as the quantity of reduction in deep percolation is expected to be limited.

The Proposed Project also encourages the update of DWR Bulletin 118. This document update would help generate a better understanding of groundwater resources in California, but would not be expected to affect the groundwater resources.

Because any construction-related reduction in groundwater levels would be temporary and there would be no such reductions related to project operations, there is no substantial evidence that this impact would be significant. This conclusion is based on the review of environmental analyses of similar projects and other pertinent evidence cited in this EIR, and on the inability to identify a reasonably plausible scenario in which a potential significant impact would occur. It is therefore concluded that this impact would likely be **less than significant**. Future project-specific analyses may develop adequate information to arrive at a different conclusion; however, for the purposes of this program-level analysis, there is no available information to indicate that another finding is warranted or supported by substantial evidence.

3.4.3.1.3 Impact 3-3a: Substantially Change Water Supply Availability to Water Users That Use Delta Water

The Proposed Project encourages a variety of actions to improve local and regional water reliability while reducing the use of Delta water, including actions to increase the use of recycled wastewater and stormwater, groundwater and surface water facilities, surface water and wellhead treatment facilities, water use efficiency and conservation actions, water transfers, and ocean desalination plants. Such water supply reliability projects would provide a benefit to water supply availability to water users that use Delta water.

3.4.3.2 Delta Ecosystem Restoration

As described in Section 2A, Proposed Project and Alternatives, and Section 2B, Introduction to Resource Sections, the Delta Plan does not direct the construction of specific projects, nor would projects be implemented under the direct authority of the Delta Stewardship Council. However, the Delta Plan seeks to improve the Delta ecosystem by encouraging various actions and projects that, if taken, could lead to completion, construction, and/or operation of projects that could improve the Delta ecosystem.

Features of such projects and actions that could be implemented as part of efforts to restore the Delta ecosystem include the following:

- Floodplain restoration
- Riparian restoration
- Tidal marsh restoration
- Stressor management
- Invasive species management (including removal of invasive vegetation)
- Delta flow and water quality objectives to be set by the SWRCB

The number and location of all potential projects that could be implemented is not known at this time. Five projects or project locations, however, are known to various degrees and are named in the Delta Plan. These are:

- Cache Slough Complex (includes Prospect Island Restoration Project)
- Cosumnes River-Mokelumne River Confluence: North Delta Flood Control and Ecosystem Restoration Project
- Lower San Joaquin River Bypass Proposal
- Suisun Marsh Habitat Management, Preservation, and Restoration Plan (includes Hill Slough Restoration Project)
- Yolo Bypass

Of these five, the Suisun Marsh project has undergone project-specific environmental review (Suisun Marsh Habitat Management, Preservation, and Restoration Plan Draft EIS/EIR [Reclamation et al. 2010]).

In addition, the Proposed Project includes recommendations that could influence the Delta Conservancy Strategic Plan and acquisition of a variance for USACE Vegetation Policy. These programs would not be expected to affect water resources.

The Proposed Project also encourages DFG’s Stage Two Actions for Nonnative Invasive Species (which could influence water quality) and encourages the SWRCB to update the WQCP for the San Francisco

Bay/ Sacramento-San Joaquin Delta Estuary and develop, implement, and enforce updated flow requirements for the Delta and high-priority tributaries in the Delta watershed that are necessary to achieve coequal goals. As described in Section 2A, Proposed Project and Alternatives, these actions likely would result in a more natural flow regime in the Delta and Delta tributaries and reduced export of water from the Delta. Water users in the areas outside the Delta that use Delta water would likely respond to reduced supplies by constructing facilities to improve water supply reliability and improve water quality. The impacts on water quality and groundwater resources associated with these actions would be the same as those described in Section 3.4.3.1, Reliable Water Supply, and Section 3.4.3.3, Water Quality Improvement.

3.4.3.2.1 Impact 3-1b: Violate Any Water Quality Standards or Waste Discharge Requirements or Substantially Degrade Water Quality

Construction Effects

Construction-related activities at ecosystem restoration sites, including the five locations identified above, could require movement of soil and the use of heavy equipment. All of these activities could present the potential to cause temporary sediment disturbance, erosion, siltation, and re-suspension.

The Suisun Marsh Habitat Management, Preservation, and Restoration Plan Draft EIS/EIR (Reclamation et al. 2010) provides an example of water quality impacts during construction activities of tidal marsh restoration. According to this EIR, construction activities would cause temporary degradation of water quality during dredging, accompanied by possible increases in mercury concentrations (Reclamation et al. 2010). However, the impacts were determined to be less than significant, and no mitigation was required assuming the writing and implementation of a SWPPP and Erosion Control Plan.

Effects of Project Operation

Operations of new floodplains, channels, or restoration areas could create long-term changes in the balance of sedimentation and scour within channels or newly-created restoration areas and may create new areas of relatively long hydraulic retention times.

The use of biocides applied for invasive species control could have temporary or lasting impacts as chemical impacts on non-target species, although these materials would be applied in compliance with label restrictions. In addition, the control of invasive aquatic plants could influence sediment dynamics in areas where dense stands of aquatic plants influence sediment transport.

Documents reviewed for potential impacts included EIRs for the North Delta Flood Control and Ecosystem Restoration Project (DWR 2010c), which analyzed proposed flood management and ecosystem restoration projects in the Delta, and the Suisun Marsh Habitat Management, Preservation, and Restoration Plan Draft EIS/EIR (Reclamation et al. 2010), which addressed ecosystem restoration in the Suisun Marsh. These EIRs provide examples of water quality impacts and mitigation from these and similar types of projects. Both of these examples found that the water quality impacts could be mitigated to a less-than-significant level.

Concerning marsh salinity, the Suisun EIR found that the additional tidal wetlands within the Suisun Marsh would increase the tidal flows throughout the Marsh channels and could increase the salinity in the channels between the Suisun Bay and the new tidal wetlands. The magnitude of the salinity effects would depend on the location and size of the new tidal wetlands (Reclamation et al. 2010).

As described in Section 2A, Proposed Project and Alternatives, the development of future flow and water quality objectives would likely result in a more natural flow regime in the Delta and Delta tributaries. These objectives would likely emphasize Delta ecosystem habitat beneficial uses by providing increased Delta outflows in the winter, spring, and fall months, and increased Delta inflows from the Sacramento and San Joaquin rivers in the winter and spring months (SWRCB 2010c). These types of flow changes could increase the presence of freshwater in the Delta in the winter, spring, and fall months. They could also reduce Delta outflows in the summer months, which could lead to increased salinity in the western Delta at those times.

Overall, these water quality changes would benefit native species that evolved with the natural flow regime that the objectives would seek to emulate. However, they could be detrimental to nonnative species that have recently inhabited the western Delta and are adapted to the salinity patterns of existing conditions.

Increased freshwater flows in the winter, spring, and fall months would improve water quality for Delta water users. Increased salinity in the western Delta in the summer months, however, could cause adverse impacts to water users of Delta water, especially agricultural users that rely upon irrigation primarily during the summer months.

Project-level impacts would be addressed in future site-specific environmental analysis conducted at the time such projects are proposed by lead agencies. However, because of the potential for sediment disturbance, the introduction of biocides to waterways, the increase in water salinity close to new tidal marshes, and salinity changes in the Delta, the potential impacts are considered **significant**.

3.4.3.2.2 Impact 3-2b: Substantially Deplete Groundwater Supplies or Interfere Substantially with Groundwater Recharge

Construction Effects

Levee modification and the construction of associated infrastructure may require de-watering activities during the construction phase of the project. This de-watering would result in a temporary reduction in groundwater levels that would be expected to return to pre-construction levels quickly after termination of de-watering activities.

Effects of Project Operation

The implementation of ecosystem restoration projects such as floodplain or riparian restoration similar to the ones encouraged by the Delta Plan and listed above, have the potential to locally raise shallow groundwater levels.

The modification of Delta flow objectives by the SWRCB, as encouraged by the Proposed Project, would potentially affect water resource reliability in areas outside of the Delta that use Delta water. As a result, alternative water supplies such as groundwater pumping will need to be considered by water users. However, the Proposed Project encourages the sustainable use of groundwater supplies, to avoid adverse effects on groundwater supplies.

The increase in groundwater levels could result in higher yields in nearby shallow wells and therefore be a benefit to shallow wells in some areas. Under the Proposed Project, the potential increase in groundwater extraction in areas outside of the Delta that use Delta water would occur in accordance with sustainable groundwater management plans and thus would not result in overdraft of local groundwater supplies. Therefore, no adverse impacts from ecosystem restoration projects are expected on groundwater levels and yields of domestic and municipal wells. This impact would be **less than significant.**

3.4.3.2.3 Impact 3-3b: Substantially Change Water Supply Availability to Water Users That Use Delta Water

Under the Proposed Project, the SWRCB would be encouraged to modify Delta flow objectives in order to place more emphasis on creating a natural flow regime in the Delta. Such objectives would likely reduce the amount of water available for municipal, agricultural, and industrial water uses within the Delta and outside the Delta. This change has the potential to affect water supply reliability, but other aspects of the Proposed Project would ensure that such an impact would be less than significant.

Because the SWRCB would consider all beneficial uses during the development of Delta flow objectives, it is anticipated that Delta water would continue to be available for municipal, agricultural, and industrial water uses, but at a reduced amount.

To make up for this reduction, water users would undertake the projects and actions encouraged by the Proposed Project to improve water supply reliability, as discussed in Section 2A, Proposed Project and Alternatives, and summarized in Section 3.4.3.1. It is anticipated that with implementation of these projects and actions, the total water supply available would remain the same or increase as compared to existing conditions depending upon the capacities of the facilities and extent of water transfers through a combination of continued use of Delta water, water use efficiency and conservation programs, and implementation of new local and regional water supplies.

In most municipal areas, increased use of recycled wastewater and recycled stormwater would increase local and regional water supplies. These programs could require local surface water storage and/or groundwater storage facilities to match supply to demand; stormwater flows primarily occur in winter and spring months, and wastewater recycling amounts are generally constant throughout the year, but municipal water demand generally peaks in the summer and fall months. Construction of new surface water treatment plants, ocean desalination plants, and wellhead treatment facilities would allow for use of water resources that are not currently utilized. Sustainable groundwater management plans will allow regional groundwater projects to provide an additional water supply only if overall groundwater storage is not adversely affected.

Water transfers also could be a major water supply source for both municipal and agricultural water users. Water could be transferred from local and regional storage facilities for use in other regions. Water transfers currently occur between SWP and CVP water users. However, if existing contractual and institutional provisions are modified, as the Proposed Project encourages, additional water transfers could occur more frequently.

The environmental effects of constructing and operating such facilities and actions are analyzed throughout this EIR in each section’s analysis of the impacts of water supply reliability projects.

Through the development of these facilities and actions, in combination with continued reliance upon Delta water supplies for a portion of the total water demands, it is anticipated that water users would continue to meet anticipated water demands even as the new flow objectives reduce the Delta’s contribution to the total water supply.

Because of the availability of alternative water supplies and continued availability of Delta water supplies, there is no substantial evidence that this impact would be significant. This conclusion is based on the inability to identify a reasonably plausible scenario in which a potential significant impact would occur. It is therefore concluded that this impact would likely be **less than significant**. Future project-specific analyses may develop adequate information to arrive at a different conclusion; however, for purposes of this program-level analysis, there is no available information to indicate that another finding is warranted or supported by substantial evidence.

3.4.3.3 Water Quality Improvement

As described in Section 2A, Proposed Project and Alternatives, and Section 2B, Introduction to Resource Sections, the Delta Plan does not direct the construction of specific projects, nor would projects be implemented under the direct authority of the Delta Stewardship Council. However, the Delta Plan seeks to improve water quality by encouraging various actions and projects that, if taken, could lead to completion, construction, and/or operation of projects that could improve water quality.

Actions would include implementation of plans/programs that lead to reduced constituents from agricultural runoff and wastewater treatment plants.

Associated projects could include construction and operation and maintenance of:

- Water treatment plants
- Conveyance facilities (pipelines and pumping plants)
- Wastewater treatment and recycle facilities
- Municipal stormwater treatment facilities
- Agricultural runoff treatment (eliminate, capture and treat/reuse)
- Wellhead treatment facilities
- Wells (withdrawal, recharge, and monitoring)

The number and location of all potential actions and projects that could be implemented is currently not known. Various projects, however, are known to some degree and are named in the Delta Plan. These are:

- Central Valley Drinking Water Policy
- CV-SALTS
- Water Quality Control Plan Update for the San Francisco Bay/ Sacramento-San Joaquin Delta Estuary (water flow objectives update)
- SWRCB/Central Valley RWQCB Strategic Workplan
- Complete the following regulatory processes, research, and monitoring:
  - Central Valley Pesticide Total Maximum Daily Load and Basin Plan Amendment for diazinon and chlorpyrifos
  - Central Valley Pesticide Total Maximum Daily Load and Basin Plan Amendment for pyrethroids
  - Total Maximum Daily Load and Basin Plan Amendments for selenium and methylmercury
- North Bay Aqueduct Alternative Intake Project

3.4.3.3.1 Impact 3-1c: Violate any Water Quality Standards or Waste Discharge Requirements or Substantially Degrade Water Quality

Construction Effects

Construction of treatment and conveyance facilities associated with projects to improve water quality and encouraged by the Proposed Project could require ground disturbance. These facilities, as was described above for water supply facilities, would have the potential to cause temporary sediment disturbance, siltation, and re-suspension of sediment-associated contaminants such as selenium, mercury, other metals, or organic contaminants. Discharges from facilities such as wastewater treatment plants, would be regulated by the SWRCB and RWQCBs, thus significant impacts for the regulated pollutants would not be expected.

As an example of the types of water quality impacts that could result from facility construction, the Davis-Woodland Water Supply Project Draft EIR (City of Davis and City of Woodland 2007) evaluated impacts to water quality resulting from the construction of a water treatment facility. According to this EIR, there could be impacts related to a violation of water quality discharge requirements or a degradation of water quality at construction sites. However, mitigation measures that included implementation of standard construction-related BMPs for erosion control would reduce the impact to less than significant.

As described in Section 3.4.3.2.1, the Proposed Project encourages the SWRCB to accelerate the completion of the Water Quality Control Plan Update for San Francisco Bay/Sacramento-San Joaquin Delta Estuary. This process would develop future flow and water quality standards that would likely result in a more natural flow regime in the Delta and Delta tributaries, which would improve water quality and potentially avoid violation of water quality standards. However, the new flows could result in reduced export of water from the Delta, which would potentially affect water supplies for water users in the areas outside the Delta that use Delta water. The impacts of water supply projects constructed and operated to respond to possible changes in the amount of water exported from the Delta caused by new flow and water quality standards would be the same as those described in Section 3.4.3.1.1.

Effects of Project Operation

Operations of surface water treatment facilities associated with projects to improve water quality could include new intakes associated with water treatment facilities. Operation of intake facilities within the rivers and streams upstream of the Delta or in the Delta could result in changes in salinity in the Delta by reducing Delta freshwater inflows during some periods of the year. The North Bay Aqueduct Intake Alternative, the Central Valley Drinking Water Policy, the implementation of the various TMDLs associated with the Delta watershed (see Appendix D list of TMDLs), and the CV-SALTS program all are intended to provide improvements in water quality. As an example, the Davis-Woodland Water Supply EIR (City of Davis and City of Woodland 2007), as indicated above, evaluated water quality impacts similar to the projects encouraged by the Proposed Project. In that document, the lead agency found that changes in flows caused by the project, as available through hydrologic modeling results, had the potential to influence salinity and water temperature in some parts of the Delta, but that those impacts would be less than significant because the diversion was less than 1 percent of Delta inflow. Project-level impacts would be addressed in future site-specific environmental analysis conducted at the time such projects are proposed by lead agencies. However, because of the potential for sediment disturbance, notably during construction activities, the potential impacts are considered **significant**.

3.4.3.3.2 Impact 3-2c: Substantially Deplete Groundwater Supplies or Interfere Substantially with Groundwater Recharge

Construction Effects

The construction of the various treatment plants, intakes, and pipelines encouraged by the Proposed Project, such as the North Bay Aqueduct Alternative Intake Project, would likely require de-watering activities during the construction phase of the project. This de-watering would result in a temporary reduction in groundwater levels that would be expected to return to pre-construction levels quickly after termination of de-watering activities.

Effects of Project Operation

The operation of water quality projects included in the Proposed Project, such as wastewater treatment plants, would have no effect on groundwater levels. Since the operation of these projects would not result in a reduction in groundwater levels or depletion in groundwater supplies, no impacts would be anticipated.

Because any construction-related reduction in groundwater levels would be temporary and there would be no such reductions related to project operations, there is no substantial evidence that this impact would be significant. This conclusion is based on the review of environmental analyses of similar projects and other pertinent evidence cited in this EIR, and on the inability to identify a reasonably plausible scenario in which a potential significant impact would occur. It is therefore concluded that this impact would likely be **less than significant**. Future project-specific analyses may develop adequate information to arrive at a different conclusion; however, for purposes of this program-level analysis, there is no available information to indicate that another finding is warranted or supported by substantial evidence.

3.4.3.3.3 Impact 3-3b: Substantially Change Water Supply Availability to Water Users That Use Delta Water

The Proposed Project would encourage construction of treatment and conveyance facilities associated with projects to improve water quality. This would increase the overall availability of water supplies to water users that use Delta water, thus providing a benefit. The new Delta flow objectives discussed in Section 3.4.3.2.3 above are also a part of the Proposed Project's efforts to improve water quality, and would have the impacts analyzed there.

Because of the availability of alternative water supplies and continued availability of Delta water supplies discussed in Section 3.4.3.2.3, there is no substantial evidence that this impact would be significant. This conclusion is based on the inability to identify a reasonably plausible scenario in which a potential significant impact would occur. It is therefore concluded that this impact would likely be **less than significant**. Future project-specific analyses may develop adequate information to arrive at a different conclusion; however, for purposes of this program-level analysis, there is no available information to indicate that another finding is warranted or supported by substantial evidence.

3.4.3.4 Flood Risk Reduction

As described in Section 2A, Proposed Project and Alternatives, and Section 2B, Introduction to Resource Sections, the Delta Plan does not direct the construction of specific projects, nor would projects be implemented under the direct authority of the Delta Stewardship Council. However, the Delta Plan seeks to reduce the risk of floods in the Delta by encouraging various actions that, if taken, could lead to completion, construction, and/or operation of projects that could reduce flood risks in the Delta. Such projects and their features could include the following:

- Setback levees (construction and maintenance)
- Floodplain expansion (construction and maintenance)
- Levee maintenance
- Levee modification
- Dredging
- Stockpiling of rock for flood emergencies
- Subsidence reversal
- Reservoir reoperation

The number and location of all potential projects that would be implemented is not known at this time. One possible project, however, is known to some degree and is named in the Delta Plan, specifically the Sacramento Deep Water Ship Channel and Stockton Deep Water Ship Channel Dredging (the USACE's *Delta Dredged Sediment Long-Term Management Strategy* included in Appendix C, Attachment C-7, of this EIR). The Proposed Project also names DWR's *A Framework for Department of Water Resources Investments in Delta Integrated Flood Management*, which could, upon completion, provide guidance on the prioritization flood protection investments.

3.4.3.4.1 Impact 3-1d: Violate any Water Quality Standards or Waste Discharge Requirements or Substantially Degrade Water Quality

Construction Effects

Construction of levees (e.g., those that could result from the Framework for Department of Water Resources Investments in Delta Integrated Flood Management) and ground-disturbing activities conducted in floodplains would cause temporary sediment disturbance siltation and re-suspension related to construction similar to that described above for water supply and water quality facility construction. However, because the extent of disturbance would be substantially greater, these actions could have a higher potential to result in significant impacts.

Effects of Project Operation

Operations of new floodplains or levees may create long-term changes in the balance of sedimentation and scour within channels or newly created restoration areas that may affect the bioavailability of certain pollutants (e.g. mercury, selenium). Impacts could result from siltation and the re-suspension of sediment-associated pollutants or from the enhancement of bioavailability of mercury or selenium in new, highly organic, marsh areas. As an example, the North Delta Flood Control and Ecosystem Restoration Project Final EIR (DWR 2010c), which evaluated water quality impacts associated with levee modification, found that the release of pollutants and organic carbon would be less than significant, whereas the release of methylmercury required the use of mitigation to reduce the impact to a less-than-significant level. The suggested mitigation involves the participation in an Offset Program to ensure no net increase in methylmercury loading.

Dredging associated with flood risk reduction would likely result in the re-suspension of sediment-associated contaminants and could temporarily cause water column enhanced bioavailability to certain contaminants (e.g. mercury, selenium). An example of these types of impacts comes from the Sacramento Deep Water Ship Channel and Stockton Deep Water Ship Channel Maintenance Projects, which are named in the Proposed Project, which include dredging of the channels to provide for improved conveyance capacity. The Draft Supplemental EIS/EIR for the Sacramento River Deep Water Ship Channel (USACE 2011b) described potential impacts to water quality and associated mitigation measures. Water quality impacts for this project were determined to be either less than significant or less than significant with mitigation, such as pre-testing of sediments, the use of submerged dredge cutterheads, and upland disposal of dredged spoils.

Project-level impacts would be addressed in future site-specific environmental analysis conducted at the time such projects are proposed by lead agencies. However, projects encouraged to decrease flood risk have the ability to cause both short-term construction impacts and long-term impacts associated with operations and changes in Delta watershed hydrology, which could affect water quality. Therefore, the potential impacts are considered **significant**.

3.4.3.4.2 Impact 3-2d: Substantially Deplete Groundwater Supplies or Interfere Substantially with Groundwater Recharge

Construction Effects

The construction of the various flood risk control measures (levee modification, floodplain expansion, subsidence reversal etc.) associated with the Proposed Project would likely require de-watering activities during the construction phase of the project. This de-watering would result in a temporary reduction in groundwater levels that would be expected to return to pre-construction levels quickly after termination of de-watering activities.

Effects of Project Operation

In general, the operation of the project features included in the Proposed Project would not likely affect groundwater levels in the vicinity; therefore, impacts would not be anticipated. Subsidence reversal methods in the Delta, such as planting tules and flooding the area, might result in greater groundwater levels in the vicinity. This is a benefit to groundwater levels in the vicinity of the subsidence-reversal project.

The Proposed Project encourages the completion of the Sacramento Deep Water Ship Channel and Stockton Deep Water Ship Channel Dredging. However, these activities would not be expected to impact groundwater levels or recharge.

There is no substantial evidence that this impact would be significant. This conclusion is based on the review of environmental analyses of similar projects and other pertinent evidence cited in this EIR, and on the inability to identify a reasonably plausible scenario in which a potential significant impact would occur. It is therefore concluded that this impact would likely be **less than significant**. Future project-specific analyses may develop adequate information to arrive at a different conclusion; however, for purposes of this program-level analysis, there is no available information to indicate that another finding is warranted or supported by substantial evidence.

3.4.3.4.3 Impact 3-3d: Substantially Change Water Supply Availability to Water Users That Use Delta Water

Flood risk reduction projects encouraged by the Proposed Project could include the construction of levees and operable barriers along the levees, levee maintenance, levee modification, expansion of floodplains, and sediment removal from channels. These actions would not change the availability of water supplies to water users that use Delta water; therefore, there would be **no impact**.

3.4.3.5 Protect and Enhance Delta as an Evolving Place

As described in Section 2A, Proposed Project and Alternatives, and Section 2B, Introduction to Resource Sections, the Delta Plan does not direct the construction of specific projects, nor would projects be implemented under the direct authority of the Delta Stewardship Council. However, the Delta Plan seeks to protect and enhance the Delta as an evolving place by encouraging various actions and projects that, if taken, could lead to completion, construction, and/or operation of associated projects. Features of such actions could include the following:

- Gateways, bike lanes, parks, trails, and marinas and facilities to support wildlife viewing, angling, and hunting opportunities (construction, maintenance, and use of recreation facilities)
- Additional retail and restaurants in legacy towns to support tourism (construction and use)

The number and location of all potential projects that could be implemented are not known at this time. However, three possible projects are known to some degree and are named in the Delta Plan: new State Parks at Barker Slough, Elkhorn Basin, and in the southern Delta.

3.4.3.5.1 Impact 3-1e: Violate Any Water Quality Standards or Waste Discharge Requirements or Substantially Degrade Water Quality

Construction Effects

Construction-related activities for gateways, bike lanes, parks, trails, marinas, fishing or wildlife viewing facilities, retail, and restaurants could result in a small amount of ground disturbance or in-channel activity, which could cause temporary sediment disturbance, erosion, and re-suspension related to construction. These types of impacts could also apply to the future State Parks encouraged by the Proposed Project. The Bidwell-Sacramento River State Park Habitat Restoration and Outdoor Recreational Facilities Development Project EIR (California Department of Parks and Recreation 2008) is an example of a planning document addressing these and similar water quality impacts and mitigation. In this EIR, impacts to water quality were determined to be less than significant through the use of standard construction BMPs and SWPPPs.

Effects of Project Operation

The operation of new marinas in the Delta would potentially increase in the amount of boating on the Delta waterways. Increased boating would cause the increase in exhaust and fuel spills, which could affect water quality. Spill prevention can be implemented through standard marina and boat owner guidelines available at the Office of Spill Prevention and Response at the California Department of Fish and Game (available at http://www.dfg.ca.gov/ospr/).

The operation of other types of recreational facilities, such as gateways, bike lanes, parks, trails, fishing or wildlife viewing facilities, retail, and restaurants, are not expected to have any significant long-term effects on water quality, as no direct discharges of pollutants to the waterways are anticipated.

Project-level impacts would be addressed in future site-specific environmental analysis conducted at the time such projects are proposed by lead agencies. However, because of the potential for sediment disturbance notably during construction activities, the potential impacts are considered **significant**.

3.4.3.5.2 Impact 3-2e: Substantially Deplete Groundwater Supplies or Interfere Substantially with Groundwater Recharge

Construction Effects

The construction of the various facilities and associated infrastructure, such as gateways, marinas, retail and restaurants facilities, would not likely require de-watering activities during the construction phase of the project, and therefore would not impact groundwater levels.

Effects of Project Operation

The development of new parks, such as those encouraged by the Proposed Project, may result in an increase in paved areas and/or the modification of current vegetation. However, the scale of these modifications likely would be small. Therefore, effects on groundwater recharge would not be significant. Therefore, groundwater levels and groundwater supplies would not be depleted.

There is no substantial evidence that this impact would be significant. This conclusion is based on the inability to identify a reasonably plausible scenario in which a potential significant impact would occur. It is therefore concluded that this impact would likely be **less than significant**. Future project-specific analyses may develop adequate information to arrive at a different conclusion; however, for purposes of this program-level analysis, there is no available information to indicate that another finding is warranted or supported by substantial evidence.

3.4.3.5.3 Impact 3-3e: Substantially Change Water Supply Availability to Water Users That Use Delta Water

Delta enhancement projects encouraged by the Proposed Project would include the construction of recreational trails, community gateways and visitor centers, new parks, and waterfowl hunting opportunities, and additional retail and restaurants in legacy towns to support tourism. These actions would not change water supply availability to water users that use Delta water, so there would be **no impact**.

3.4.3.6 Mitigation Measures

Any covered action that would have one or more of the significant environmental impacts listed above shall incorporate the following features and/or requirements related to such impacts.

With regard to covered actions implemented under the Delta Plan, these mitigation measures would reduce the impacts of the Proposed Project. Project-level analysis by the agency proposing the covered action would determine whether the measures are sufficient to reduce those impacts to a less-than-significant level. Generally speaking, many of these measures are commonly employed to minimize the severity of an impact and in many cases would reduce impacts to a less-than-significant level, as discussed below in more detail.

With regard to actions taken by other agencies on the basis of Delta Plan recommendations (i.e., activities that are not covered actions), the implementation and enforcement of these measures would be within the responsibility and jurisdiction of public agencies other than the Delta Stewardship Council. Those agencies can and should adopt these measures as part of their approval of such actions, but the Delta

Stewardship Council does not have the authority to require their adoption. Therefore, significant impacts of noncovered actions could remain **significant and unavoidable**.

How mitigation measures in this EIR relate to covered and uncovered actions is discussed in more detail in Section 2B, Introduction to Resource Sections.

3.4.3.6.1 Mitigation Measure 3-1

The following mitigation measures would reduce the effects of Impact 3-1a though 3-1e:

- For construction of new facilities, all typical construction mitigation measures shall be required. Typical mitigation measures include the following construction-related BMPs:
  - Gravel bags, silt fences, etc., shall be placed along the edge of all work areas in order to contain particulates prior to contact with receiving waters.
  - All concrete washing and spoils dumping shall occur in a designated location.
  - Construction stockpiles shall be covered in order to prevent blowoff or runoff during weather events.
  - Severe weather event erosion control materials and devices shall be stored onsite for use as needed.
- Other BMPs as determined necessary by the regulating entity (city, county).
- Any new facility with introduced impervious surfaces shall include stormwater control measures that are consistent with the RWQCB NPDES municipal stormwater runoff requirements. The stormwater control measures shall be designed and implemented to reduce the discharge of stormwater pollutants to the maximum extent practical. Stormwater controls such as bioretention facilities, flow-through planters, detention basins, vegetative swales, covering pollutant sources, oil/water separators, and retention ponds shall be designed to control stormwater quality to the maximum extent practical.
- Mitigate sediment contaminant bioavailability impacts through the exclusion of bird use or nesting areas from areas that may have excessive selenium or mercury.

For any construction activities with the potential to cause in-river sediment disturbance associated with construction:

- Apply BMPs to avoid or reduce temporary increases in suspended sediment. These BMPs for in-channel construction and levee disturbance may include, but are not limited to, silt curtains, cofferdams, the use of environmental dredges, erosion control on all inward levee slopes, and various levee-stabilization techniques, including revegetation. All construction sites will include preparation of a Storm Water Pollution Prevention Plan and BMPs designed to capture spills and prevent erosion to the waterbody. Turbidity shall be monitored up- and downstream of construction sites as a measure of impact.
- Apply bank stabilization BMPs, as needed, for any in-channel disturbance, such as:
  - A 100-foot vegetative or engineered buffer shall be maintained between the construction zone and surface water body.
  - Native and annual grasses or other vegetative cover shall be established on construction sites immediately upon completion of work causing disturbance, to reduce the potential for erosion close to a waterway or water body.

Dredging would be particularly prone to the production of re-suspended sediment and contaminants, but potential impacts could be reduced, but not necessarily fully mitigated, through the use of submerged dredge cutter heads, silt curtains, and cofferdams, depending upon the site-specific soil conditions within the channel.

This mitigation measure will likely reduce the water quality impact to a less than significant level. However, as discussed above, with regard to actions taken by other agencies on the basis of the Delta Plan recommendations (i.e., activities that are not covered actions), the implementation and enforcement of these measures would be within the responsibility and jurisdiction of public agencies other than the Council. For these reasons, sediment- and erosion-related water quality impacts would remain significant.

3.4.3.6.2 Mitigation Measure 3-2

Although in many cases Impacts 3-2a through 3-2e are likely to be less than significant, the following mitigation measures are recommended to ensure that impacts do not exceed that level:

- Prior to construction, a survey should be made of all wells located adjacent to the construction site to determine location and depths of the wells and the groundwater surface. During construction of any project that requires dewatering of groundwater, monitoring wells should be installed adjacent to the groundwater dewatering wells or pumps. If the adjacent groundwater declines in a manner that would adversely affect adjacent wells following implementation of dewatering, the dewatering operations should be halted until the following measures are be implemented:,
    - Install sheet piles to reduce the area influenced by shallow groundwater level declines.
    - In case sheet piles are not an option and domestic well yields are affected, water supplies shall be trucked in to satisfy the well user’s water supply needs.
    - If sheet piles are not effective and the impact on the well yield is important, such that the trucking in of water is not economically feasible, the affected well shall be deepened. Another option for a well that is deep enough would be to lower the pump bowl such that deepened water can be pumped out of the well. If these two options are not feasible, a new, deeper, replacement well shall be installed for groundwater production.

This mitigation measure will likely reduce the construction-related groundwater level impact to a less than significant level. However, as discussed above, with regard to actions taken by other agencies on the basis of the Delta Plan recommendations (i.e., activities that are not covered actions), the implementation and enforcement of these measures would be within the responsibility and jurisdiction of public agencies other than the Delta Stewardship Council. For these reasons, construction-related groundwater level impacts would remain **significant**.

3.4.4 No Project Alternative

As described in Section 2A, Proposed Project and Alternatives, the No Project Alternative is based on the continuation of existing plans and policies and the continued operation of existing facilities into the future and permitted and funded projects. Several ongoing projects have been identified as part of the No Project Alternative. The list of projects included in the No Project Alternative is presented in Table 2-2.

The No Project Alternative includes various water supply projects and one ecosystem enhancement project, as described in Section 2A, Proposed Project and Alternatives. However, the Delta Plan would not be in place to encourage various other projects to move forward. These projects are all under construction. To the extent the absence of the Delta Plan results in those projects not happening, there would be no water supply impacts as compared to the existing conditions.

Compared to the Proposed Project, the No Project Alternative would result in fewer actions and projects to improve water supply reliability, restore the Delta ecosystem, and improve water quality, and no projects to reduce flood risk and protect and enhance the Delta as an evolving place. Overall, the reduced number of projects and actions under the No Project Alternative would change water resources resulting from construction and operation of surface water intakes/diversions, small-scale storage reservoirs, conveyance, and tidal marsh ecosystem restoration. In addition to a general reduction in the number of projects with relatively small construction footprints, the large-scale surface water storage facilities and increased levee modification and maintenance encouraged under the Proposed Project would not move forward under the No Project Alternative, and the impacts associated with these projects would not occur.

Importantly, however, the benefits to water resources resulting from reduced flood risk and improved water supply reliability and quality would not be realized under the No Project Alternative.

As described in the environmental setting discussion, Delta levees have periodically failed and could continue to fail under the No Project Alternative if historical maintenance activities are not continued.

Given the reduced number and magnitude of actions under the No Project Alternative to improve the current conditions or arrest further decline on Delta water supplies, on balance the overall adverse impacts on water resources resulting from the No Project Alternative would be **greater than** those under the Proposed Project, even though temporary impacts from construction would be fewer.

3.4.5 Alternative 1A

Under Alternative 1A, the construction and operation of surface water projects (water intakes, treatment and conveyance facilities, and reservoirs) would be the same as those of the Proposed Project, and the completion of the DWR Surface Water Storage Investigation and Bulletin 118 would be encouraged, as in the Proposed Project. As described in Section 2A, Proposed Project and Alternatives, there would be fewer groundwater projects (wells, wellhead treatment, conveyance facilities), ocean desalination projects, recycled wastewater and stormwater projects (treatment and conveyance facilities), and water transfers relative to the Proposed Project. Water use efficiency and conservation programs also would be reduced.

Projects to restore the Delta ecosystem would be reduced relative to the Proposed Project and the implementation of flow objectives that could lead to a more natural flow regime in the Delta would not be accelerated. Stressor management activities and invasive species management (including removal of invasive vegetation) would be the same as described for the Proposed Project.

Projects and actions to improve water quality would be the same as under the Proposed Project. Flood risk reduction projects also would be the same as the Proposed Project, except that levee maintenance and modification would place less emphasis on levees that protect agricultural land and more emphasis on levees that protect water supply corridors, which could result in an overall reduction in these activities. Projects to protect and enhance the Delta as an evolving place would be the same as the Proposed Project.

3.4.5.1.1 Impact 3-1: Violate Any Water Quality Standards or Waste Discharge Requirements or Substantially Degrade Water Quality

The same type of water quality impacts from construction and operations would occur under Alternative 1A as described under the Proposed Project. However, the impacts associated with construction and operation of groundwater projects, ocean desalination projects, and recycled wastewater and stormwater projects would be reduced because there would be fewer facilities constructed. Construction of levees in the Delta also would be less likely under Alternative 1A, thus reducing the potential for violating water quality standards associated with their construction.

As described for the Proposed Project, many individual projects have the potential to cause short or long-term exceedances of water quality standards or to otherwise cause water quality degradation. Projects that create new shallow, sediment-accumulating marshy areas with increased hydraulic retention time, including ecosystem restoration sites, could contribute to enhanced bioavailability and risk from bioaccumulative contaminants such as selenium, mercury, or organochlorine compounds. Because habitat restoration actions under Alternative 1A would be reduced relative to the Proposed Project, the potential for these types of impacts would be reduced. .

Given the reduced number and magnitude of actions under the Alternative 1A to improve the current conditions or arrest further decline, on balance the overall adverse impacts on water resources resulting from Alternative 1A would be **greater than** those under the Proposed Project, even though temporary impacts from construction might be fewer.

As compared to existing conditions, the impacts to water quality under Alternative 1A would be **significant.**

3.4.5.1.2 Impact 3-2: Substantially Deplete Groundwater Supplies or Interfere Substantially with Groundwater Recharge

The same types of temporary and permanent impacts to groundwater resulting from implementation of Proposed Project would occur under Alternative 1A. Alternative 1A encourages fewer local-scale surface water and groundwater storage projects as compared to the Proposed Project. As a result, potential impacts on groundwater from surface water and groundwater storage construction and operation would occur in fewer areas.

Alternative 1A also results in less emphasis on improving delta ecosystem habitat, and therefore impacts associated with ecosystem restoration would be reduced. Finally, Alternative 1A has less emphasis on levee construction than the proposed project and construction impacts related to levee construction would be reduced.

The other changes associated with Alternative 1A relative to the Proposed Project would not be expected to affect groundwater.

Given the reduced number and magnitude of actions under the Alternative 1A, overall significant impacts on groundwater supplies and recharge under Alternative 1A would be **less than** the Proposed Project.

As compared to existing conditions, the impacts on groundwater supplies and recharge under Alternative 1A would be **significant.**

3.4.5.1.3 Impact 3-3: Substantially Change Water Supply Availability to Water Users Located Outside of the Delta That Use Delta Water

Under Alternative 1A, unlike the Proposed Project, development of the flow objectives would not be required to be completed by a specific date. Alternative 1A would thus have similar effects relating to water supplies as the Proposed Project and could lead and encourage water users of Delta water to improve local and regional water supply reliability in a manner similar to that described in Impact 3-3b. The need for improved local and regional supply reliability would, however, be somewhat less acute and would occur farther in the future.

Impacts on water supply availability under Alternative 1A would be **the same** overall as for the Proposed Project.

As compared to existing conditions, the impacts on water supply availability under Alternative 1A would be **less than significant**.

3.4.5.2 Mitigation Measures

Mitigation measures for Alternative 1A would be the same as described for Impacts 3-1, 3-2, and 3-3 for the Proposed Project. Because it is not known whether these mitigation measures would reduce impacts to a less-than-significant level, these impacts are considered **significant.**

3.4.6 Alternative 1B

Under Alternative 1B, the construction and operation of surface water projects (water intakes, treatment and conveyance facilities, and reservoirs) would be the same as the Proposed Project. As described in Section 2A, Proposed Project and Alternatives, there would be fewer groundwater projects (wells, wellhead treatment, and conveyance facilities), recycled wastewater and stormwater projects (treatment and conveyance facilities). Water transfers and water use efficiency and conservation programs would be reduced relative to the Proposed Project. There would be no ocean desalination projects.

Projects to restore the Delta ecosystem would be reduced in extent relative to the Proposed Project and would not emphasize restoration of floodplains in the lower San Joaquin River. Implementation of flow objectives would not be accelerated or include public trust considerations. Stressor management activities and invasive species management (including removal of invasive vegetation) would be increased relative to the Proposed Project.

Flood risk reduction would place greater emphasis on levee modification/maintenance and dredging than the Proposed Project, but there would be no setback levees or subsidence reversal projects. Floodplain expansion projects would be fewer or less extensive, as would reservoir reoperation. Actions to protect and enhance the Delta as an evolving place would be consistent with the Economic Sustainability Plan, but the locations for new parks, as encouraged by the Proposed Project, would not be emphasized.

3.4.6.1.1 Impact 3-1: Violate Any Water Quality Standards or Waste Discharge Requirements or Substantially Degrade Water Quality

The same type of water quality impacts from construction and operation of water supply facilities would occur under Alternative 1B as described under the Proposed Project. A reduction in groundwater projects, and recycled wastewater and stormwater projects could result in a decreased likelihood of water quality violations. Similarly, fewer restoration actions would reduce the potential for increasing the bioavailability and risk from bioaccumulative contaminants such as selenium, mercury, or organochlorine compounds. Less levee construction would also reduce the potential for water quality violations during construction.

An increase in stressor and invasive species management could result in an increase in the use of herbicides to control vegetation. Assuming the application of these materials would be made in compliance with the label restrictions, these activities should not result in water quality violations.

Given the reduced number and magnitude of actions under the Alternative 1B, overall significant impacts on water quality under Alternative 1B would be **less than** the Proposed Project because of the reduction in the construction of water supply facilities and levees.

As compared to existing conditions, the impacts to water quality under Alternative 1B would be **significant.**

3.4.6.1.2 Impact 3-2: Substantially Deplete Groundwater Supplies or Interfere Substantially with Groundwater Recharge

The same type of temporary and permanent impacts to groundwater due to implementation of the Proposed Project would occur under Alternative 1B. Alternative 1B would place less emphasis on water transfers and completion of surface water and groundwater storage projects. Therefore, impacts associated with the construction and operation of these features may be decreased. Alternative 1B also would place less emphasis on ecosystem restoration, which would reduce impacts to groundwater from these activities, as compared to the Proposed Project.

Given the reduced number and magnitude of actions under the Alternative 1B, overall significant impacts on groundwater supplies and recharge under Alternative 1B would be **less than** the Proposed Project.

As compared to existing conditions, the impacts on groundwater supplies and recharge under Alternative 1B would be **significant.**

3.4.6.1.3 Impact 3-3: Substantially Change Water Supply Availability to Water Users Located Outside of the Delta That Use Delta Water

Under Alternative 1B, unlike the Proposed Project, development of the flow objectives would not be required to be completed by a specific date. The need for improved local and regional supply reliability would, thus, be less acute and farther in the future as compared to the Proposed Project. Implementation of Alternative 1B could lead water users of Delta water to improve local and regional water supply reliability as discussed in Impact 3-3b. Alternative 1B does not encourage some types of projects, including groundwater, recycling, and desalination, to the same extent as the Proposed Project, however, because the SWRCB would consider all beneficial uses—including municipal and agricultural uses—in setting flow objectives, such objectives would likely provide for sufficient Delta exports to meet the needs of out-of-Delta users, despite the lower level of local water projects under this alternative.

Overall significant impacts on water supply availability would be the **same as** those of the Proposed Project.

As compared to existing conditions, the impacts related to water supplies under Alternative 1B would be **significant.**

3.4.6.2 Mitigation Measures

Mitigation measures for Alternative 1B would be the same as those described for Impacts 3-1, 3-2, and 3-3 for the Proposed Project. Because it is not known whether these mitigation measures would reduce impacts to a less-than-significant level, these impacts may be considered **significant.**

3.4.7 Alternative 2

As described in Section 2A, Proposed Project and Alternatives, Alternative 2 would place greater emphasis on groundwater, ocean desalination, water transfers, water use efficiency and conservation, and recycled water projects and less emphasis on surface water projects. The surface storage reservoirs considered under the DWR Surface Water Storage Investigation would not be encouraged; instead, the surface storage in the Tulare Basin would be emphasized. Ecosystem restoration projects similar to, but less extensive than those encouraged by the Proposed Project, would be emphasized. Alternative 2 would emphasize the development of flow objectives that take into consideration updated flow criteria that support a more natural flow regime, water rights, and greater protection of Public Trust resources.

Actions to improve water quality would be similar to or greater than the Proposed Project, especially the treatment of wastewater and agricultural runoff. Actions to reduce flood risk under Alternative 2 would emphasize floodplain expansion and reservoir reoperation rather than levee construction and modification. The stockpiling of materials and encouragement of subsidence reversal projects would be the same as the Proposed Project, as would actions to protect and enhance the Delta as an evolving place.

3.4.7.1.1 Impact 3-1: Violate Any Water Quality Standards or Waste Discharge Requirements or Substantially Degrade Water Quality

The same type of water quality impacts described for facility construction and operations under the Proposed Project would occur under Alternative 2. The reduced emphasis on surface water supply facilities could reduce the potential for water quality impacts associated with construction. Similarly, the reduced emphasis on ecosystem restoration, particularly large tracts of wetland habitats, and a greater emphasis on terrestrial and other habitat restoration could reduce the potential for increasing the bioavailability and risk from bioaccumulative contaminants such as selenium, mercury, or organochlorine compounds. However, subsidence reversal projects that include shallow flooding could increase this potential. In addition, the emphasis on more protective water quality and flow standards in the Delta would likely result in beneficial impacts on water quality.

Alternative 2 emphasizes the development and implementation of flow standards for the Delta and tributaries that focus on the protection of the Public Trust resources. This emphasis on resource protection would likely improve water quality in the Delta relative to the Proposed Project.

Alternative 2 would remove from agricultural production approximately 320,000 acres of land in Tulare Lake Basin and 380,000 acres of land in the San Luis Drainage Area that have historically required drainage facilities, including subsurface drains and evaporation ponds. Historically, many of these facilities have violated water quality standards and waste discharge requirements. Landowners have recently implemented or are implementing facilities to reduce the water quality violations. However, water quality problems continue in specific portions of these areas. Alternative 2 would reduce these ongoing water quality impacts.

Overall, significant impacts on water quality under Alternative 2 would be **less than** the Proposed Project.

As compared to existing conditions, the impacts to water quality under Alternative 2 would be **significant.**

3.4.7.1.2 Impact 3-2: Substantially Deplete Groundwater Supplies or Interfere Substantially with Groundwater Recharge

The same type of temporary and permanent impacts to groundwater described for the Proposed Project would occur under Alternative 2. Alternative 2 would provide more emphasis on development of local and regional water supplies, such as groundwater projects, ocean desalination projects, and an emphasis on recycled wastewater and stormwater projects. Impacts associated with these activities on groundwater may be increased.

Alternative 2 recommends construction of a storage reservoir in the Tulare Basin, which is located in a region outside of the Delta watershed. The types of impacts on groundwater levels and recharge would be similar to the ones described for the reservoir construction in the Proposed Project. The Tulare Lake Basin is the only reservoir encouraged by Alternative 2, as compared to the Proposed Project, which encourages the construction of three reservoirs as part of the DWR Surface Water Storage Investigation. However, the Tulare Lake Basin reservoir would be larger than the three DWR Surface Water Storage Investigation reservoirs combined. As discussed above, surface storage facilities are likely to provide a benefit to groundwater supplies. Therefore, the overall adverse impact to groundwater from the construction of reservoirs in Alternative 2 is likely to be less than for the Proposed Project.

Alternative 2 recommends more emphasis on water transfers than the Proposed Project. In the case of groundwater water substitution transfers, this might impact groundwater levels in the area that provides the transferred water, as described in Section Impact 3-2a. Similarly, the increase in groundwater projects, as compared to the Proposed Project, might increase the amount of construction dewatering needed to complete these projects, which lowers groundwater levels in the vicinity. As a result, Alternative 2 might have a greater impact on groundwater levels and recharge than the Proposed Project.

Alternative 2 also provides increased emphasis on developing more natural hydrographs on rivers upstream of the Delta. This would likely increase groundwater recharge of the affected aquifer systems and increase local groundwater levels, which constitutes a benefit to groundwater.

Overall, significant adverse impacts on groundwater supplies and recharge under Alternative 2 would be **less than** the Proposed Project.

As compared to existing conditions, the impacts on groundwater supplies and recharge under Alternative 2 would be **significant.**

3.4.7.1.3 Impact 3-3: Substantially Change Water Supply Availability to Water Users Located Outside of the Delta That Use Delta Water

Alternative 2, like the Proposed Project, would encourage the implementation of Delta flow objectives, but under Alternative 2, flow objectives would be developed to prioritize beneficial uses of the ecosystem in the Delta watershed and the Delta as compared to other beneficial uses of Delta water. This could further reduce the amount of Delta water available to water users. However, the extent of activities associated with groundwater projects, ocean desalination, recycled wastewater and stormwater projects, water transfers, and water use efficiency and conservation programs would be greater under Alternative 2 than the Proposed Project, thus improving users' ability to make up for that reduction.

However, these alternative water sources may not be able to prevent water supply impacts under Alternative 2. Currently, about 5 MAF/year is available for SWP and CVP municipal, agricultural (including a portion of land that rely upon drainage programs), and industrial water contractors. Under Alternative 2, the maximum Delta diversion for water users located outside of the Delta would be 3 MAF and Delta water could not be used for irrigation of land that require drainage program. Because the CVP would continue to provide over 1.1 MAF/year to San Joaquin River water rights Exchange Contractors and San Joaquin Valley federal and State wildlife refuges, there would be less than 2 MAF/year for the remaining municipal, agricultural, and industrial contractors and no water for irrigated agriculture that relies upon drainage programs.

Municipal and industrial water users are located in areas that would support more extensive development of new local and regional water supply facilities than anticipated under the Proposed Project. It is also possible that municipal water users could implement stringent water use efficiency and conservation measures, such as reduction in outside landscape irrigation. Thus, for municipal and industrial water users, water users that use Delta water will likely continue to meet anticipated water demands, even as the amount of Delta water would become a smaller portion of the total water supply or may substantially reduce the water demands.

Agricultural water users may be more limited in alternative water supplies. Groundwater, including currently contaminated groundwater that could become available following wellhead treatment and expansion of groundwater storage, will be an important source, as will water transfers. However, the need for new local and regional water supplies may exceed available alternative supplies. Most agricultural water users are not located near the ocean to obtain water from ocean desalination treatment plants or surface waters that could provide water to local surface water storage facilities. Alternative 2 also would eliminate irrigation water to a portion of the San Joaquin Valley that requires drainage programs to maintain adequate groundwater quality and elevation to allow for successful crop cultivation. Therefore, there would be a substantial loss of irrigation water supply to users outside of the Delta under Alternative 2 as compared to existing conditions. This loss of water could cause agricultural land uses to convert from irrigated crops to non-irrigated crops or to be fallowed.

Overall, significant impacts on water supply availability under Alternative 2 would be **greater than** for the Proposed Project.

As compared to existing conditions, the impacts on water supply availability under Alternative 2 would be **significant.**

3.4.7.2 Mitigation Measures

Mitigation measures for Alternative 2 would be the same as those described for Impacts 3-1, 3-2 and 3-3 for the Proposed Project. Because it is not known whether the mitigation measures listed above would reduce impacts to a less-than-significant level, these impacts may be considered **significant.**

3.4.8 Alternative 3

As described in Section 2A, Proposed Project and Alternatives, the water supply reliability projects and actions under Alternative 3 would be similar to those of the Proposed Project, although there would less emphasis on surface water projects. Ecosystem restoration (floodplain restoration, riparian restoration, tidal marsh restoration, and floodplain expansion) would be reduced relative to the Proposed Project and emphasize restoration on publicly owned lands, especially in Suisun Marsh and the Yolo Bypass. There would be more stressor management actions (e.g., programs for water quality, water flows) and more management for nonnative invasive species. Water quality improvements would be the same as the Proposed Project. Actions under Alternative 3 to reduce flood risk would not include setback levees or subsidence reversal, but would result in greater levee modification/maintenance and dredging relative to the Proposed Project. Reservoir reoperation and materials stockpiling would be the same as the Proposed Project, as would activities to protect and enhance the Delta as an evolving place.

3.4.8.1.1 Impact 3-1: Violate any Water Quality Standards or Waste Discharge Requirements or Substantially Degrade Water Quality

As described for the Proposed Project, many individual projects have the potential to cause short or long-term exceedances of water quality standards or to otherwise cause water quality degradation. Projects that create new shallow, sediment-accumulating marshy areas with increased hydraulic retention time may contribute to enhanced bioavailability and risk from bioaccumulative contaminants such as selenium, mercury, or organochlorine compounds. Alternative 3 encourages fewer ecosystem restoration projects and a similar number of water supply reliability and water quality improvement projects as compared to the Proposed Project, except for greater emphasis on levee maintenance and dredging, which would potentially increase impacts to water quality.

Overall, significant impacts on water quality under Alternative 3 would be **increased impacts as compared to** the Proposed Project and all would be temporary.

As compared to existing conditions, the impacts to water quality under Alternative 3 would be **significant.**

3.4.8.1.2 Impact 3-2: Substantially Deplete Groundwater Supplies or Interfere Substantially with Groundwater Recharge

The same type of temporary and permanent impacts to groundwater resulting from the Proposed Project would occur under Alternative 3. Alternative 3 provides less emphasis on the development of local and regional water supplies and ecosystem restoration. Therefore, implementation of Alternative 3 may result in fewer impacts to groundwater associated with the construction and operation of these project features.

Alternative 3 has a greater emphasis on levee modification and maintenance, which would not significantly impact groundwater. As described for the Proposed Project, levee construction and modification would only impact groundwater levels on a short-term basis during construction dewatering operations. Thus, even if more levee work is encouraged in Alternative 3 as compared to the Proposed Project, the impacts to groundwater would only temporarily be greater than for the Proposed Project.

Overall, significant impacts on groundwater supplies and recharge under Alternative 3 would be **less than** the Proposed Project.

As compared to existing conditions, the impacts on groundwater supplies and recharge under Alternative 3 would be **significant.**

3.4.8.1.3 Impact 3-3: Substantially Change Water Supply Availability to Water Users Located Outside of the Delta That Use Delta Water

Alternative 3, like the Proposed Project, would encourage the implementation of Delta flow objectives. Alternative 3 would thus have similar effects relating to water supplies as the Proposed Project and could lead and encourage water users of Delta water to improve local and regional water supply reliability in a manner similar to that described in Impact 3-3b. Surface water would be less available, but there would be increased use of recycled wastewater and recycled stormwater, local surface water storage and/or groundwater storage facilities, new surface water treatment plants, ocean desalination plants, wellhead treatment facilities, and transfers, thus increasing local and regional water supplies. Therefore, through the development of new local and regional water supply facilities and continued reliance upon Delta water supplies for a portion of the total water demands, it is anticipated that water users that use Delta water would continue to meet anticipated water demands, even as the amount of Delta water could become a smaller portion of the total water supply.

Overall, significant impacts on water supply availability under Alternative 3 would be **the same** as for the Proposed Project.

As compared to existing conditions, the impacts on groundwater supplies and recharge under Alternative 3 would be **less than significant.**

3.4.8.2 Mitigation Measures

Mitigation measures for Alternative 3 would be the same as those described for Impacts 3-1, 3-2 and 3-3 for the Proposed Project. Because it is not known whether the mitigation measures listed above would reduce impacts to a less-than-significant level, these impacts may be considered **significant.**

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